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NORFOLK HARBOR AND CHANNELS DEEPENING STUDY REPORT 1

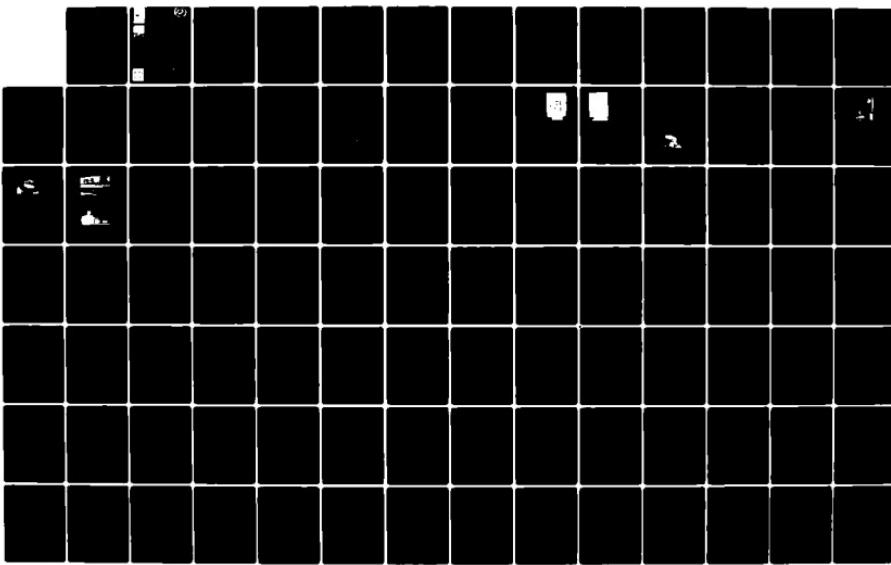
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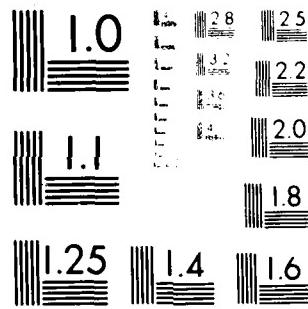
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TECHNICAL REPORT HL-83-13



NORFOLK HARBOR AND CHANNELS DEEPENING STUDY

Report 1

PHYSICAL MODEL RESULTS

Chesapeake Bay Hydraulic Model Investigation

by

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P. O. Box 631, Vicksburg, Miss. 39180



June 1983

Final Report

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Prepared for U. S. Army Engineer District, Norfolk
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20. ABSTRACT (Continued).

The steady-state tests showed that tides would remain unaffected by channel deepening while the velocity studies indicated some subtle changes caused by the deepening. An overall decrease in velocity amplitude of 0.13 fps was noticed in the deepened condition. This decrease, however, was barely detectable by model instrumentation. Slight increases in flood predominance were noticed under average inflow conditions indicating that salinity intrusion may move upstream in the study area.

The dynamic tests served two purposes. First, they were intended to define the salinity patterns in detail throughout the lower Chesapeake Bay which had previously not been done, particularly with regard to the presence of the "neap-spring" salinity response to varying tide conditions. The study detected a strong neap-spring response in the study area and documented its magnitude at each of the stations in the lower Chesapeake Bay. Second and most important was predicting what changes to the existing salinity character of Chesapeake Bay would be brought on by the proposed channel deepening.

Salinity sampling stations were located at 193 positions throughout the Chesapeake Bay system with the vast majority being located near the project area in the lower bay and James River areas. A 2-1/2-year weekly stepped variable hydrograph taken from historical records and a 28-lunar-day, 56-cycle, 12-constituent variable tide were used as boundary conditions. Source salinity was maintained at a constant 32 ppt which is indicative of low flow conditions.

Results from 65 stations are given in the form of time-histories, plan-minus-base difference plots, depth-averaged and depth-averaged difference plots, isohaline and bottom difference maps. The graphics document the following observations:

- a. Neap-spring variations in salinity stratification are prevalent throughout the lower bay and project areas. Commonly, the variations are as great as 5 to 8 ppt at a given depth.
- b. Channel deepening caused an increase in salinity intrusion that was normally confined to the deepened channel areas. Adjacent shallow-water areas showed very little change in salinity. Areas outside the project area in the upper bay showed no changes that can be associated with channel deepening.
- c. Redistributions of salt within the cross section were noticed in channels with adjacent shallow-water areas. In some cases, the shallow waters freshened as the channels became saltier.
- d. Overall changes to the salinity structure could be characterized by a net increase in depth-averaged salt with an increase in stratification. Bottom variations in the neap-spring response were noticed in the form of damped salinity variations for equivalent tidal inputs.

Results of the tests indicate salinity changes to the estuary which can be attributed to channel deepening. On the average, the changes are small, normally less than 2 ppt, in an extremely dynamic portion of the estuary where natural salinity fluctuations due to variations in tides and freshwater input can cause weekly variations an order of magnitude greater.

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PREFACE

In October 1981, the U. S. Army Engineer Waterways Experiment Station (WES) was requested by the U. S. Army Engineer District, Norfolk, to perform a hydraulic model investigation of possible hydrodynamic changes to Chesapeake Bay as a result of the proposed deepening of the Norfolk approach channels.

The study was conducted by personnel of the Hydraulics Laboratory, WES, and its subcontractor Acres American, Inc., under the general direction of Messrs. H. B. Simmons, Chief of the Hydraulics Laboratory, F. A. Herrmann, Jr., Assistant Chief of the Hydraulics Laboratory, R. A. Sager, Chief of the Estuaries Division, W. M. Dyok of Acres American, Inc., and Dr. R. B. Taylor of Tetra Tech, Inc. Testing was conducted under the supervision of Messrs. R. O. Bruno, Chief of the Chesapeake Bay Model Branch (WES), and S. R. Rives of Acres American, Inc. Data analysis and final report preparation were conducted under the supervision of Messrs. Bruno of WES and J. R. Pagenkopf of Tetra Tech, Inc. Project Engineers for the model study were Messrs. D. R. Richards for WES and M. R. Morton for Acres American/Tetra Tech. Additional key personnel for WES involved in the model study included Messrs. A. W. Crunk, M. A. Granat, and Ms. V. R. Pankow. Key personnel for Acres American and Tetra Tech included Messrs. D. G. Dionne, W. E. Hayes, P. S. Jayne, P. A. Waltz, and Ms. M. F. Capriotti. Special acknowledgment is made to Mr. Crunk for providing computer graphics assistance which was used extensively in this report. This report was prepared by Messrs. Richards and Morton.

Commander and Director of WES during the conduct of this study and the preparation and publication of this report was COL Tilford C. Creel, CE. Technical Director was Mr. F. R. Brown.

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CONTENTS

	<u>Page</u>
PREFACE	1
CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT	3
PART I: INTRODUCTION	5
Chesapeake Bay	5
Norfolk Harbor	6
Proposed Channel Improvements	6
Purpose	7
Scope of Testing	9
PART II: CHESAPEAKE BAY MODEL	10
Physical Model Description	10
Computer Facilities	12
Tide Generation and Measurement	13
Freshwater Inflow	13
Sewage Treatment Plants	17
Surry Nuclear Power Plant	18
Saltwater Supply System	20
Bubbler System	20
Current Meters	20
Vacuum Sampling System	23
Salinity Testing System	23
PART III: STEADY-STATE TIDE AND VELOCITY TESTS	26
Test Conditions	26
Tide Test Data and Results	27
Velocity Tests	32
Velocity Data Analysis	36
Velocity Test Results	38
Tide and Velocity Summary	46
PART IV: DYNAMIC SALINITY TESTING	48
Test Conditions	48
Salinity Data Analysis	56
Salinity Results	57
PART V: CONCLUSIONS	73
REFERENCES	75
TABLES 1-14	
PLATES 1-236	

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI)
UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
acres	0.4647	hectares
cubic feet per second	0.02831685	cubic metres per second
feet	0.3048	metres
feet per second	0.3048	metres per second
inches	25.4	millimetres
miles (U. S. statute)	1.609344	kilometres
square feet	0.09290304	square metres

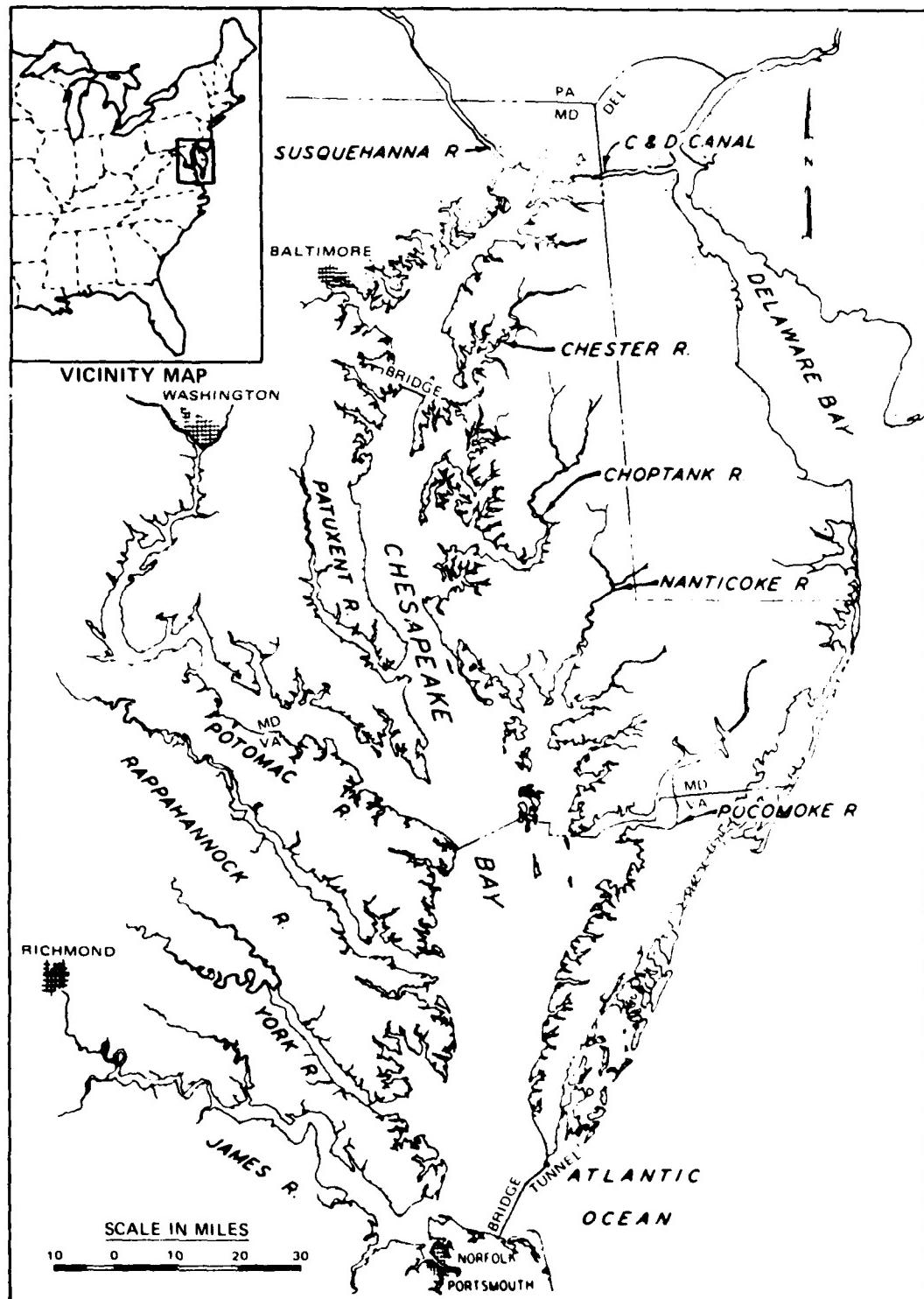


Figure 1. Location map

NORFOLK HARBOR AND CHANNELS DEEPENING STUDY

PHYSICAL MODEL RESULTS

Chesapeake Bay Hydraulic Model Investigation

PART I: INTRODUCTION

Chesapeake Bay

1. Chesapeake Bay with its tributary estuaries forms the largest estuarine system in North America. The 190-mile*-long estuary varies in width from 4 to 30 miles with an average depth of 28 ft (Figure 1). The mean annual discharge of its 126 freshwater tributaries is approximately 70,000 cfs, almost 90 percent of which is contributed by the Susquehanna, Potomac, Rappahannock, York, and James River basins. The Atlantic Ocean provides salt water to the bay, producing large salinity variations within its boundaries. The eastern shore is generally saltier than the western shore, attributed in part to the predominance of freshwater flow from the western shore tributaries and to the counterclockwise tendency of flow resulting from Coriolis force.

2. Chesapeake Bay is classified geologically as a drowned river valley estuary. The Holocene sea-level rise inundated the Susquehanna River Valley to form the bay. Sedimentation from the tributaries as well as erosion of the banks has contributed to maintaining the bay's broad, shallow character. The bay is classified as a partially mixed estuary, although various stages of freshwater discharge and tidal and wind mixing cause portions to alternate between well mixed and highly stratified. Tides are semidiurnal with mean ranges from 1 to 2 ft. The length of Chesapeake Bay is such that a complete tidal wave is contained within its limits at all times. Wind-generated waves are generally less than 3 ft in height, but larger waves can occur during high wind conditions. Average maximum velocities for tide and wind-driven currents range from 0.5 to 3 fps.

3. Chesapeake Bay contains a variety and abundance of wildlife that make it unique as a biological environment. Its estuarine waters are rich

* A table of factors for converting U. S. customary units of measurements to metric (SI) units is presented on page 3.

with nutrients and organic material that support some of the largest crops of oysters and clams in the world. The lower salinity portions of the estuary provide the spawning grounds for a variety of fishes including the striped bass, shad, and herring. Most of the organisms native to Chesapeake Bay are tolerant of natural fluctuations in the saltwater distribution, but sometimes permanent changes provide stresses that they cannot survive. The adverse effects of these sometimes man-induced changes are often realized through the depletion of existing spawning areas for fishes or by providing more conducive environments to the organisms' predators as is most noticeable in shellfish. Since man is capable of making permanent changes to the bay's salinity and hence its biota through his navigational improvement efforts, it is important to know the possible impacts on the environment prior to implementation of a project so that reasonable alternatives can be explored or trade-offs assessed in a responsible manner.

Norfolk Harbor

4. Navigational uses of Chesapeake Bay in the Norfolk area are of great importance to the Nation and the local communities. Due to its naturally protected harbors, the Norfolk area has historically been the home port of naval activities since colonial times. Commercially, Norfolk has played a major role in east coast bulk shipping for many years. Its closeness to the Appalachian coal fields and connecting rail lines has helped it become the largest coal exporting port in the United States. However, with the current trends toward deeper draft bulk cargo vessels and an ever-increasing demand for United States coal, Norfolk may lose some of this competitive advantage. There are currently several vessels calling on Norfolk that must carry partial loads to navigate through the existing channels. Since the majority of the cargo passing through Norfolk is high in volume and low in price, the efficient use of shipping is crucial to bring profits. Unless the harbor is deepened, future deep-draft vessels may be forced to use other ports.

Proposed Channel Improvements

5. The proposed improvements to channels and anchorages approaching

Norfolk Harbor are shown in Figure 2 and described as follows (USAED, Norfolk, 1980):

- a. Increasing the depth of Thimble Shoal Channel from 45 to 55 ft below mean low water over its existing 1,000-ft width.
- b. Increasing the depth of Norfolk Harbor Channel from 45 to 55 ft below mean low water over its existing 800- to 1,500-ft width to the coal terminal at Lamberts Point.
- c. Increasing the depth of the channel to Newport News from 45 to 55 ft below mean low water over its existing 800-ft width to the coal terminal at Newport News.
- d. Dredging a new channel, referred to as the Atlantic Ocean Channel, off Virginia Beach to a depth of 57 ft below mean low water and a width of 1,000 ft over a length of 10 miles.
- e. Constructing three fixed-mooring anchorage facilities, each capable of accommodating two large vessels simultaneously.
- f. Increasing the depth of the Elizabeth River - the Southern Branch of the Elizabeth River between Lambert's Point (river mile 9) and the Norfolk and Western Railway bridge (river mile 15) from 40 to 45 ft below mean low water over its existing 375- to 750-ft width.
- g. Increasing the depth of the Southern Branch of the Elizabeth River between the Norfolk and Western Railway Bridge (river mile 15) and the U. S. Routes 460 and 13 highway crossing (river mile 17.5) from 35 to 40 ft below mean low water over its existing 250- to 500-ft width, and providing a new 800-ft turning basin at the terminus of the channel improvement.

6. The depths listed above are project depths and do not include allowable overdepth dredging. The actual depths for the proposed new channels with the required overdepth dredging should be 3 ft deeper. Previous deepening projects in the vicinity also had provisions for overdepth dredging. The model study of the proposed channel deepening used the existing channel depths as determined by the most recent surveys for the base condition with the plan condition using the project depths plus the 3-ft overdepth dredging.

Purpose

7. The purpose of this study was to investigate the impact of the proposed channel deepening on the hydrodynamic characteristics of Chesapeake Bay. The study was designed specifically to determine what changes in tidal elevations, current velocities, and salinities could be attributed to the proposed channel deepening.

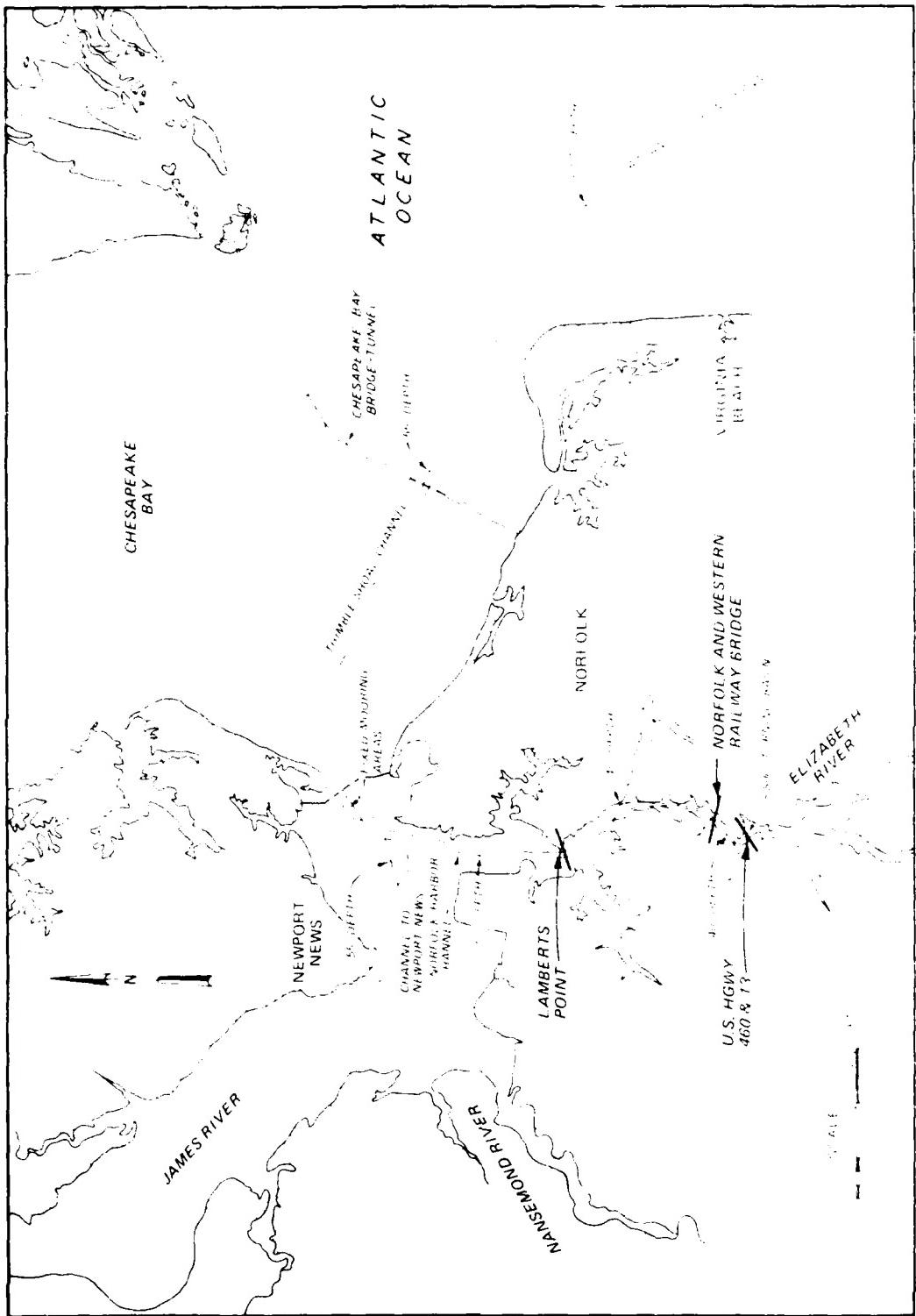


FIGURE 2 Project map showing proposed port facilities.

Scope of Testing

8. The hydraulic model study consisted of two parts. The first was a series of four steady-state tests (constant discharge and cosine tides) designed to study base versus plan differences in tides and current velocities. Both base and plan geometries were tested under medium and high tide range and freshwater discharge conditions. The boundary conditions and sampling procedures for the steady-state tests were dictated by the needs of numerical models at the U. S. Army Engineer Waterways Experiment Station (WES) for subsequent studies of sediment transport and shoaling in the dredged channels and neighboring bottom areas.

9. The second part of the study was a dynamic test (variable discharge and variable tides) designed to predict base versus plan differences in salinity response. A 2-1/2-year variable hydrograph was used with a repetitive 28-lunar-day variable tide for both base and plan geometries. The ocean source salinity was the same for both steady-state and dynamic tests.

PART II: CHESAPEAKE BAY MODEL

Physical Model Description

10. The physical model of Chesapeake Bay is located on Kent Island in Matapeake, Maryland. The model is an 8.6-acre fixed-bed model molded in concrete to conform to the most recent National Ocean Survey charts. At the time of this study, all major ship channels had been molded with the proposed 50-ft channels leading into Baltimore and the existing channels elsewhere. Channels in the James and Elizabeth Rivers and Thimble Shoal area of the Lower Bay were molded to correspond to prototype information collected as late as 1981. The molded area of the model extends from approximately 30 miles offshore in the Atlantic Ocean to the heads of tide for all tributaries emptying into the Chesapeake. The entire length of the Chesapeake and Delaware (C&D) Canal and a portion of Delaware Bay are also molded. Overbank geometry is reproduced to the +20 ft contour. Model limits are shown in Figure 3.

11. The hydraulic model was designed based on the equality of Froude numbers, model to prototype, reflecting similitude of gravitational effects. Geometric scales of the model are 1:1,000 horizontally and 1:100 vertically, reflecting a distortion ratio of 10:1. These dimensions and Froudian model laws defined the following model-to-prototype ratios:

Characteristic	Ratio
Vertical length	1:100
Horizontal length	1:1,000
Slope	10:1
Time	1:100
Velocity	1:10
Volume	1:100,000,000
Discharge	1:1,000,000

The model-to-prototype ratio for salinity is 1:1. This is the general practice for distorted-scale models.

12. The model was designed and equipped so that selected prototype boundary conditions could be simulated and the model response to these conditions recorded. A discussion of appurtenances necessary to generate and record test boundary conditions follows.

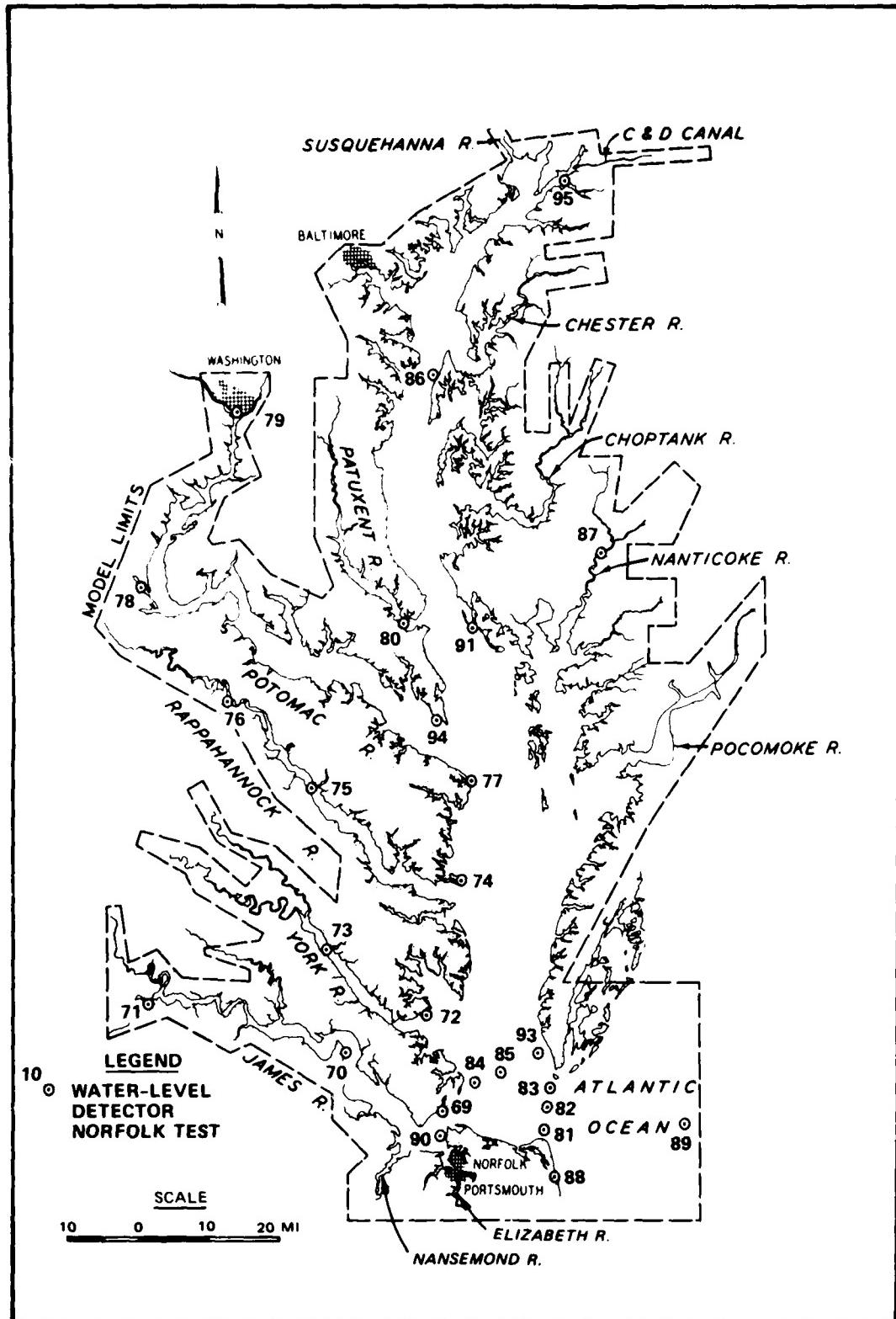


Figure 3. Model limits and automatic water-level detector locations with their computer number designations

Computer Facilities

13. The Chesapeake Bay model is equipped with five minicomputers that perform a variety of tasks ranging from model control and data logging to the analysis and graphical display of model test data. These include a Texas Instruments (TI) 960, a TI 980, an International Business Machines (IBM) 5110, a Digital Equipment Corporation (DEC) PDP 11/23, and a DEC PDP 11/44.

14. The TI 960 is a 64K minicomputer used solely for model control and data acquisition. It is equipped with a 2.5-megabyte magnetic disc that contains all necessary system software to compile and run the model control computer program. It also is equipped with two 250K flexible disc drives that are used to receive data from 75 different flowmeters and water-level detectors throughout the model. Output from these devices is displayed on a cathode-ray tube (CRT) or hardcopy terminal where it can be observed at the same time that it is recorded on flexible disc. Through the model control terminal, an operator can interactively observe model operations by displaying values from any combination of model control devices.

15. The TI 980 is a 56K minicomputer used primarily for data analysis. It has the same access to the magnetic disc and flexible discs as does the TI 960. In addition, it can interface with a 300 card-per-minute card reader, a 9-track, 800-bpi (bytes per inch) magnetic tape drive, and a Versatec electrostatic printer/plotter. Graphics for this report were partially supplied by the Versatec machine.

16. The IBM 5110 is a 64K minicomputer that has access to twin 250K flexible disc drives and Tektronix plotting peripherals. It uses an APL keyboard and is used in various data editing and analysis tasks.

17. Data logging at the model can be accomplished through the use of the PDP 11/23 minicomputer. The PDP 11/23 has 64K of main memory and can store 5.8 megabytes of data on a Winchester magnetic disc. Although it is being developed as a self-contained data logging system, it is also used for a variety of small data analysis tasks.

18. The largest of the model minicomputers is the PDP 11/44 which has a full megabyte of main memory and can service eight users simultaneously. Program and data storage in the system is supplied by twin 10.4 megabyte removable magnetic discs, a 1,600-bpi tape drive, twin 250K flexible disc drives, and a 600 card-per-minute card reader. The PDP 11/44 is connected to a

Tektronix graphics system that includes a 4112 video graphics screen, a 4662 flat bed plotter, and a 4612 hard copy unit. The graphics in this report were largely supplied by the PDP 11/44 and Tektronix system.

Tide Generation and Measurement

19. Source tides in the model can be generated by using the primary tide generator in the model ocean and by using the secondary tide generator in the Delaware Bay at the eastern end of the C&D Canal. Both tide generators can be operated to generate a repetitive tide, or by using the TI 960 model control computer a repetitive or variable tide can be generated.

20. The TI 960 computer controls the source tides by providing a continuously changing programmed voltage to the tide-generating mechanisms. These mechanisms consist of a feedback system that is entirely self-contained and is not dependent on computer feedback for adjustment. The system consists of a tide control amplifier that conditions the computer signal and a bubble tube positioner that senses the water-level position and positions the hydraulically controlled inlet and outlet gates via a hydraulic pilot amplifier. Figure 4 is a schematic of the tide-generating system. A more detailed description of the tide generators can be found in Scheffner et al. (1981).

21. Water-surface elevations throughout the model can be measured both manually by 75 distributed point gages, and automatically by 22 water-level detectors (WLD), which report their individual water levels to the computer where they are stored. Water-level elevations are monitored both manually at the ocean and automatically throughout the model during testing (Figure 3). Manual measurements at the ocean were used to check automatic devices.

Freshwater Inflow

22. The Chesapeake Bay model is capable of reproducing a variable hydrograph freshwater inflow through the use of positive feedback control of river discharges. Fresh water normally enters the model at 21 independent inflow points representing the major tributaries of the prototype. During the Norfolk test, however, an additional inflow was needed on the Elizabeth River to more accurately simulate the inflows in the lower James River watershed. Ordinarily, Elizabeth River flows enter the model through the inflow on the

OPERATION OF TIDE GENERATOR

THE WATER SURFACE OF THE MODEL (A) IS APPROXIMATELY 5FT HIGHER THAN RETURN SUMP (B) AND 10 FT LOWER THAN SUPPLY SUMP (C). BECAUSE OF THESE DIFFERENCES IN WATER-SURFACE ELEVATIONS, THE FLOW OF WATER FROM THE MODEL INTO THE RETURN SUMP AND OUT OF THE SUPPLY SUMP INTO THE MODEL IS GRAVITY FLOW. THE TWO ROLLING GATES (D&E) OPERATE IN TANDEM SUCH THAT WHEN ONE GATE IS OPENING, THE OTHER GATE IS CLOSING. WHEN THE SUPPLY SUMP ROLLING GATE (D) IS OPENING AND THE RETURN SUMP ROLLING GATE (E) IS CLOSING A NET POSITIVE FLOW RESULTS, AND THE MODEL FLOODS. WHEN THE SUPPLY SUMP ROLLING GATE IS CLOSING AND THE RETURN SUMP ROLLING GATE IS OPENING, A NET NEGATIVE FLOW RESULTS AND THE MODEL EBBS. A PUMP (F) BETWEEN THE SUMPS MAINTAINS A CONSTANT AMOUNT OF WATER IN THE SUPPLY SUMP SIGNALS FROM THE TIDE SENSOR (H) AND TIDE PROGRAMMER (I) OR COMPUTER (NOT SHOWN) ARE COMPARED BY THE TIDE CONTROL (G) WHICH THEN DETERMINES THE PROPER OPENING OF THE ROLLING GATES TO REPRODUCE THE DESIRED TIDE.

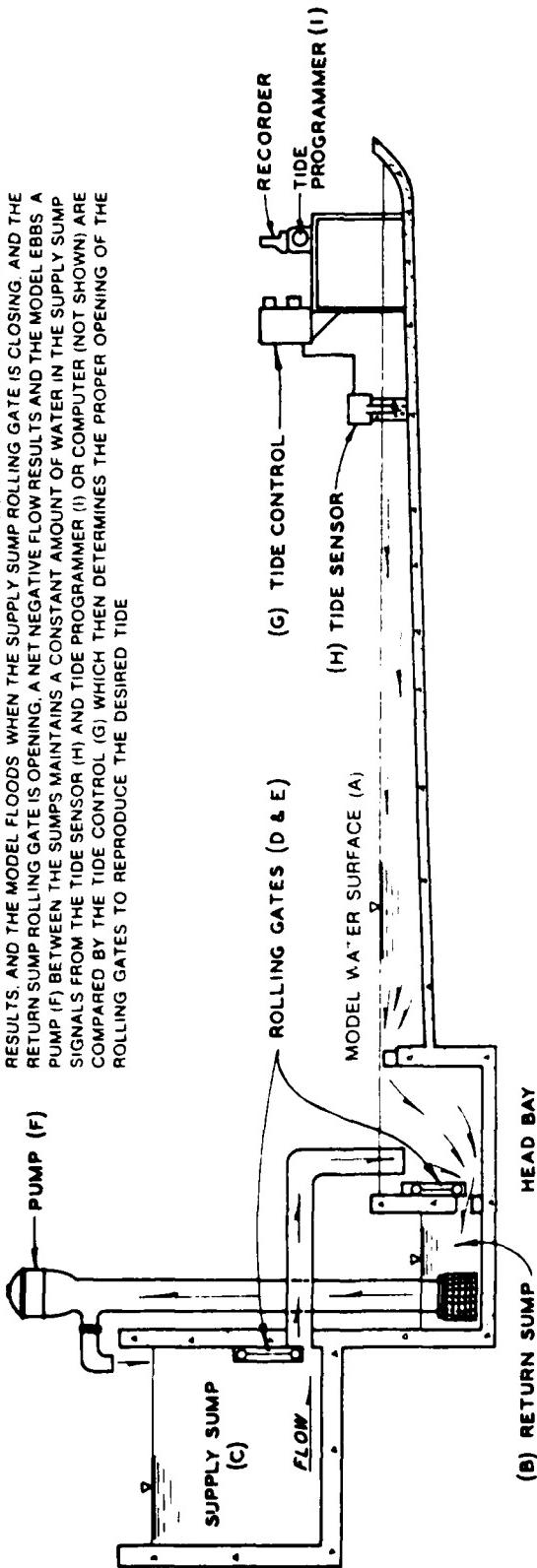


Figure 4. Tide-generating system

Nansemond River. Figure 5 is a map of the bay showing the positions of the discharge points. The Susquehanna River required two inflow systems (numbers 15 and 22) due to the range of freshwater inflow. As shown in Figure 5, both these systems lead to the same discharge point.

23. Although more than 100 separate tributaries empty into Chesapeake Bay, only 22 rivers were chosen to represent the total combined bay discharge. Providing a separate discharge point at each minor tributary is impractical. The sophisticated plumbing and equipment necessary for each inflow are expensive and require specialized maintenance. Many of the tributaries provide infinitesimal flows, immeasurable with the present system used. These flows are summed with the nominal discharge of the closest of the 22 chosen tributaries to provide a representative and well-balanced, as well as a cost-effective, inflow distribution.

24. Flow is controlled at the discharge points by an arrangement of solenoid-controlled discharge ports with graduated orifices. An electrical signal causes a solenoid to be activated, fully opening a discharge port. The configuration of the graduated orifices is such that 4,096 combinations of open and closed ports provide a range of flows which can be stepped from the smallest measurable flow to the individual tributary's maximum flow. These arrangements of ports are called digital valves.

25. Flow from the digital valves to the model is monitored continuously by bearingless flowmeters of varying ranges that can be used alone or in combinations to provide accurate flow readings covering the full range of a tributary's discharge. The flowmeters use fiber optics to count the revolutions of a water-driven rotor. Optical pulses are translated to electrical pulses that are summed on an arrangement of totalizers and latches on a counter card. This counter is strobed at predetermined intervals which causes the summed value of pulses to be transferred to a transmitter and the latches cleared for the next summation. During this study, inflows were strobed every 18 sec, or every half hour of prototype time; thus the values available for flow calculations are not instantaneous flows but are 18-sec averages.

26. Each flowmeter in use has its own transmitter where the binary totals from the counter are translated to ASCII code and transmitted to the TI 960 model control computer in serial form via a hard-wired, cascading, multiplexed 20-ma current loop communication system.

27. In the computer, the pulse totals are transformed to flows using a

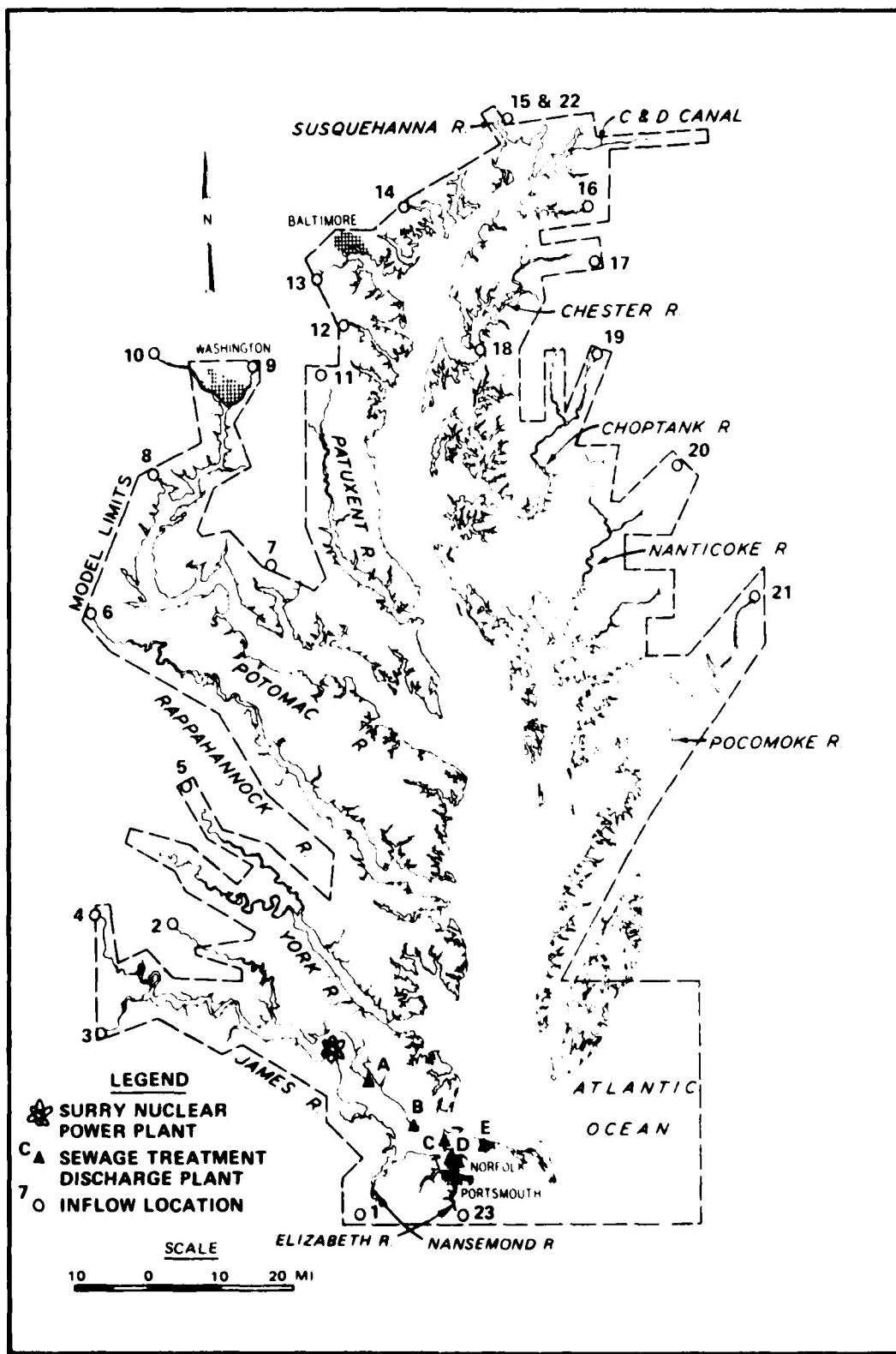


Figure 5. Freshwater inflow and sewage treatment plant locations

linear regression derived from pretest calibrations for each flowmeter/digital valve combination. The computer then compares these 18-sec averaged flows with the desired flows for each flowmeter and determines whether the digital valve setting should be adjusted at any of the inflows. The feedback system is activated when there is a discrepancy between the desired flow and the actual flow. Discharge ports are opened or closed to adjust the actual flow toward the desired flow. Time-averaged discharges controlled in this manner remain very close to the desired hydrograph step values. Some overshooting of flows may occur at the beginning of each hydrograph step as the computer adjusts, but flows are generally stable within just a few update cycles. This varies, of course, with the magnitude of the step change as well as with each individual flowmeter/digital valve combination. Figure 6 shows a typical inflow system used in this test.



Figure 6. Typical inflow system
varies, of course, with the magnitude of the step change as well as with each individual flowmeter/digital valve combination. Figure 6 shows a typical inflow system used in this test.

Sewage Treatment Plants

28. During this study, changes in discharges of the rivers were supplemented by modeling major sewage treatment plants (STP's) in the Norfolk area. Figure 5 shows the locations of the five STP's modeled for the study. Table 1 is a list of the stations with their geographical locations. Discharges A and B are located on the James River, discharges C and D are located on the Elizabeth River, and discharge E is located near Little Creek in the Lower Chesapeake Bay. Engineering drawings of the STP's were consulted and the discharge points were located as near as possible to those in the prototype. Fresh water was used as the discharge medium in all modeled STP's. Since near-field flow patterns are not easily modeled in a distorted-scale



Figure 7. Typical STP

model, and since a near-field flow/density structure was not an object of concern, no attempt was made to reproduce the injection methods of prototype. Brass diffusers were fitted to nylon tubing for outfalls. Figure 7 shows a typical portable inflow as used in the Norfolk Harbor study. A constant-head tank, approximately 10 ft above the model, feeds an array of adjustable rotameters which in turn feed the nylon discharge lines. Flow rates through the STP's were adjusted manually, as required, throughout each hydrograph test.

Surry Nuclear Power Plant

29. The cooling water diversion from the Surry Nuclear Power Plant was simulated in model testing for the

first time in the Norfolk Harbor study. The plant is located at Hog Island on the southern shore of the James River (Figures 5 and 8). Virginia Electric Power Company (VEPCO) officials have estimated the diversion at 3,740 cfs continuously even when the plant is not on line. A diversion of this magnitude is several times greater than the total James River inflow during drought conditions so its inclusion was deemed necessary for this study.

30. Engineering drawings and hydrographic surveys were consulted so that the intake and outfall geometries as well as their nearshore approach channels were modeled to closely approximate prototype conditions. Figure 8 shows the intake and outfall locations near Hog Island and the relative closeness to the nearest salinity sampling stations. During the model test, the 3,740-cfs (prototype) constant bypass was maintained by reading a discharge rotameter and adjusting a throttling valve which was attached to a constant rpm centrifugal pump (Figure 9). An identical calibrated backup pump was available in case the primary pump failed during testing. No significant differences in pump performance were noticed between the base and plan tests.

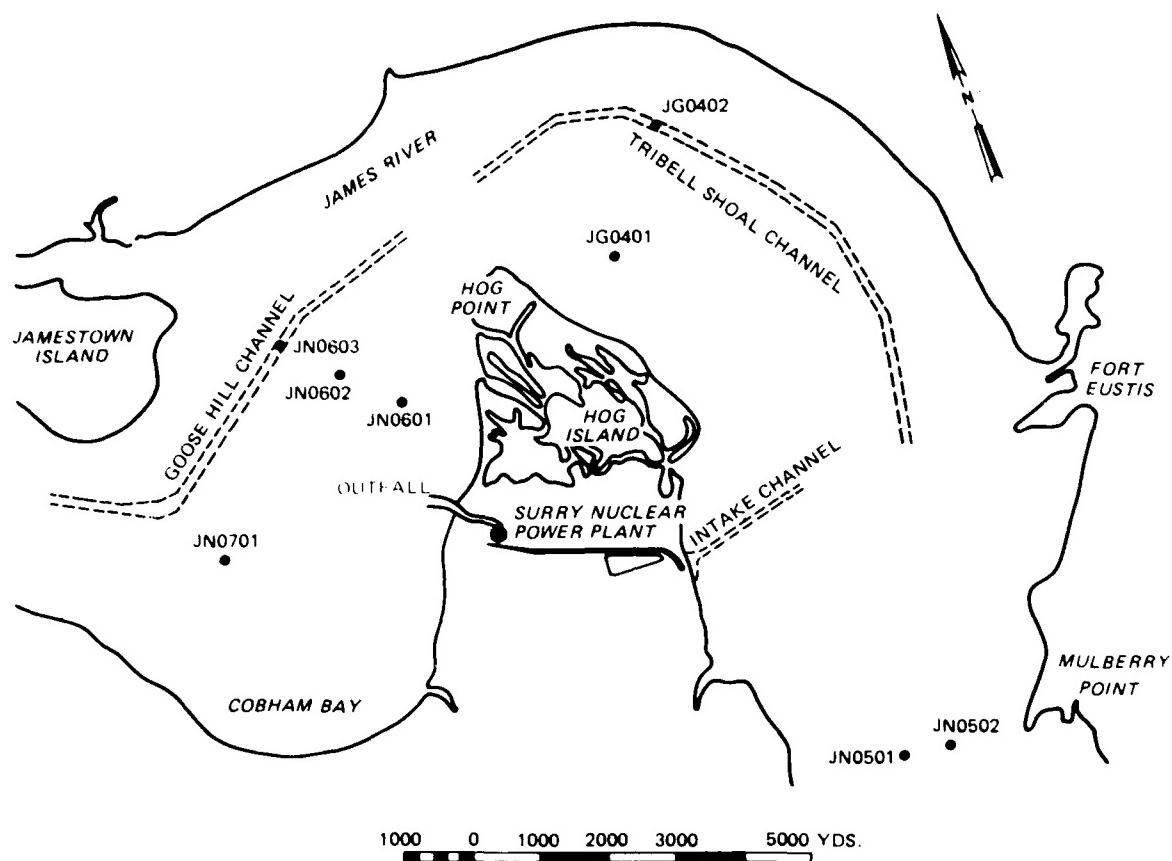


Figure 8. Surry Nuclear Power Plant intake and outfall locations

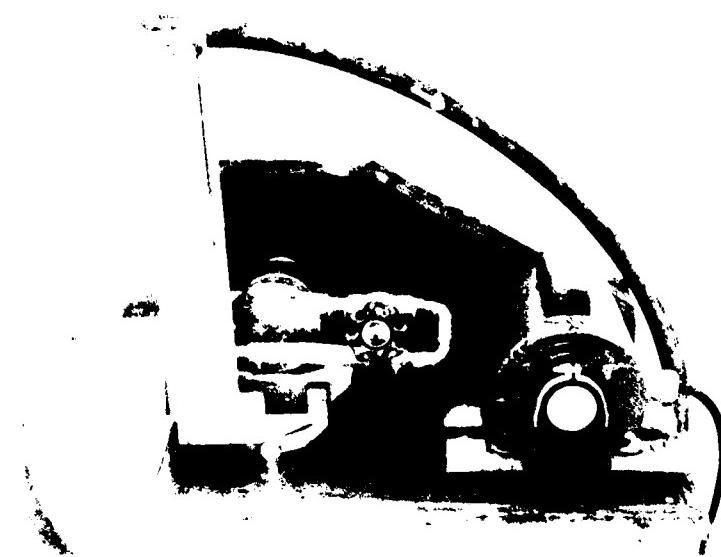


Figure 9. Surry bypass pump

Saltwater Supply System

31. A constant source salinity is provided to the model ocean by maintaining the supply sump (Figure 4) at the desired salinity. This is accomplished by adding sufficient quantities of saturated brine (approximately 280 ppt) to the return sump where it is mixed to the desired source salinity prior to being circulated to the supply sump and thence to the model ocean. The saturated brine solution is obtained by injecting fresh water into a bed of granular salt (NaCl) from which it is later released to the return sump in measured quantities. The saltwater supply system is capable of maintaining source salinity to within 0.2 ppt of that desired in steady-state conditions and to within 0.5 ppt of that desired during variable hydrographic conditions.

Bubbler System

32. The bubbler system in the model is designed to create a more realistic vertical salinity distribution. Since nonastronomical mixing energy (primarily wind) is not easily modeled by tides and supplemental roughness alone, it was necessary to add the bubbler system in order to maintain closer agreement with the vertical salinity distribution in the prototype.

33. The model bubbler system consists of a network of copper tubing placed along the axis of the bay and its major tributaries (Figure 10). The tubing is charged with a constant air pressure and releases bubbles into the water column at a constant prescribed flow rate. Throughout any given test the bubble flow rate, air pressure, and bubbler depth in the water are monitored for consistency.

Current Meters

34. In this study, both magnitude and direction of currents were sampled. Current magnitude measurements were made with miniature Price-type meters (Figure 11). The center line of the model cups on the meter was about 0.04 ft above the bottom of the meter frame. The overall width of the meter was about 0.1 ft in the model, representing a horizontal width of about 100 ft in the prototype. Therefore distortion of the horizontal area (model to prototype) resulted in model velocities averaged over a much larger area than those

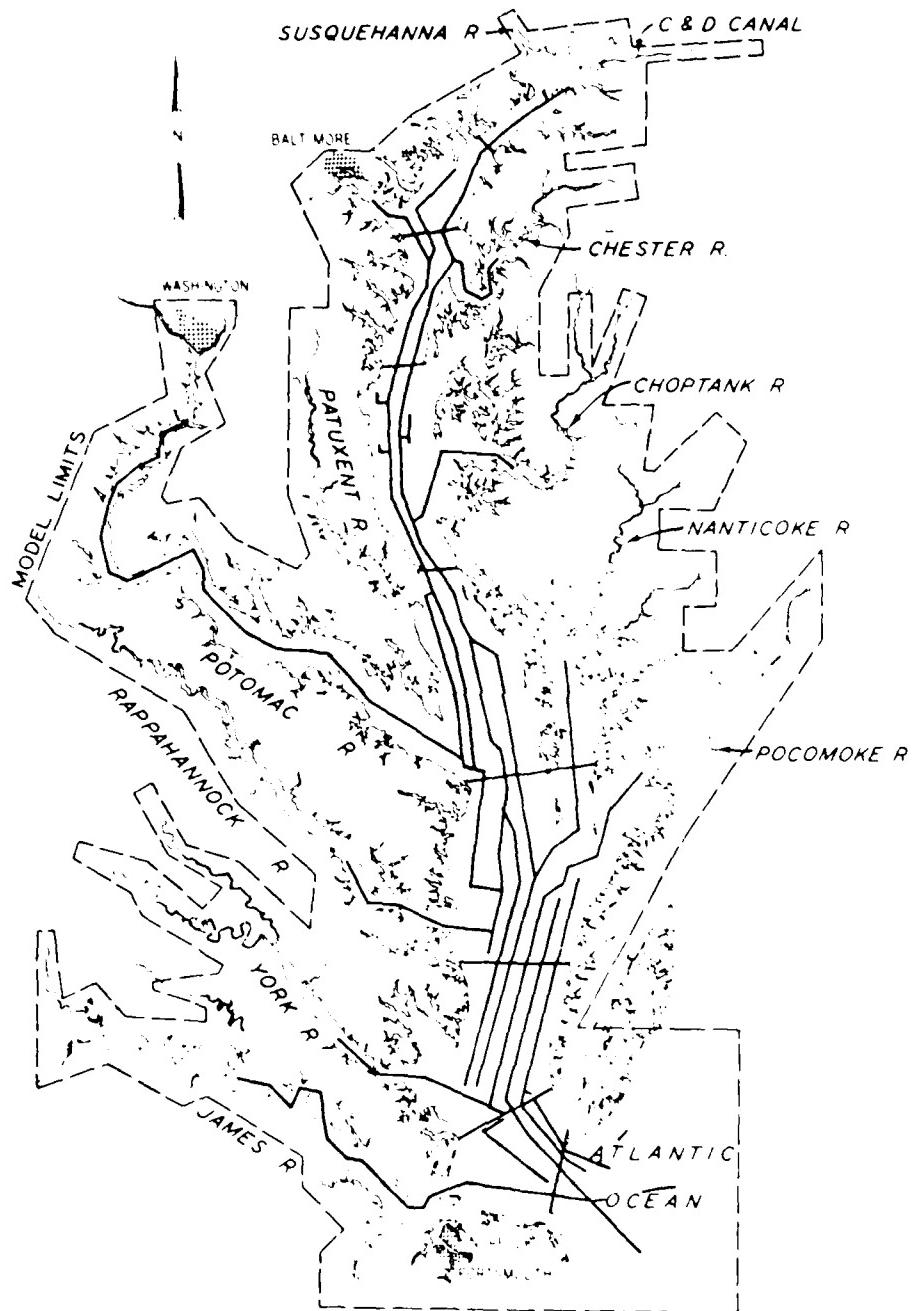


Figure 10. Bubbler system layout

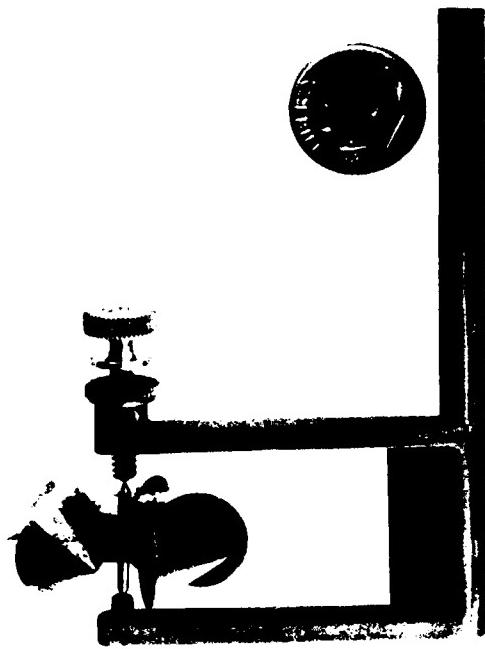


Figure 11. Miniature Price-type velocity current meter

of the prototype point observations. The same was true for the vertical area since the height of the cups on the meter was equivalent to about 4.0 ft prototype. Current speeds were obtained by counting the number of revolutions the meter made in a 10-sec interval which was equivalent to about 17 min in the prototype. The meters were calibrated frequently to ensure the accuracy of measurements and were capable of measuring actual speeds as low as about 0.03 fps (0.3 fps prototype). Accuracy of these meters was about ± 0.15 fps (prototype).

35. Current directions were recorded hourly to the nearest 10 deg by using a direction vane and direction rose as shown in Figure 12. As was true with the Price-type meters, the size of the vane results in direction readings that are an average value over its 2-ft (prototype) height. In most cases, current direction changes are fairly slow so technicians could maintain reading precision to within 10 deg.

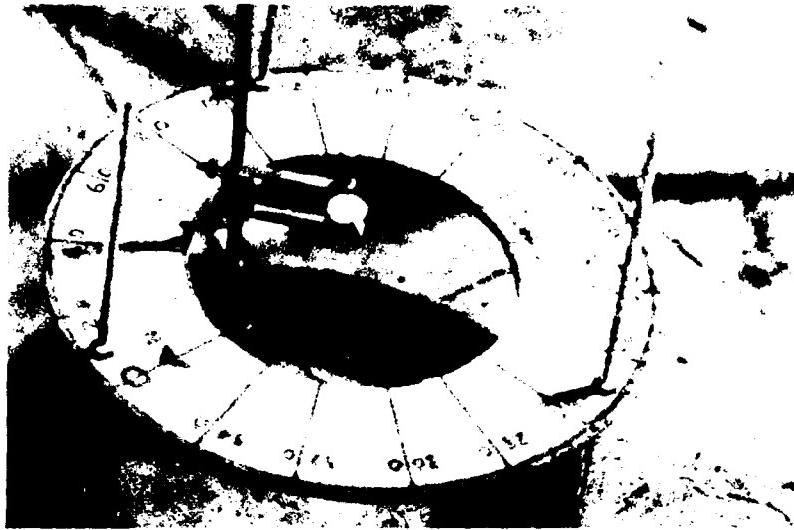


Figure 12. Current direction vane and compass rose

Vacuum Sampling System

36. Salinity samples for this test were taken using a vacuum aspiration system. A series of vacuum pumps provide a continuous vacuum to three valve manifolds. A total of 16 valves control a varying number of cotidal stations arranged such that sampling times are never more than 1/2 hr (prototype) from the desired slack-water sampling time. In each case, the sample is pulled at the same time relative to slack water. The sampling station consists of a sampling probe built from a number of separate copper tubes soldered together to form a multidepth probe. These copper tubes are attached to short lengths of plastic tubing that lead to individual 10-ml test tubes. Vacuum is provided to the tubes by a vacuum/overflow jar that provides an even vacuum to all lines. This system has proven effective in taking a very large number of samples. The filled test tubes are removed manually from the sampling device between sampling times and placed in special racks for later analysis.

Salinity Testing System

37. Beckman RA-5 solumeters are the primary instruments for making conductivity measurements at the model (Figure 13). These meters use a salinity probe shaped like an eyecdropper into which a sample is drawn and the salinity



Figure 13. Beckman solumeter

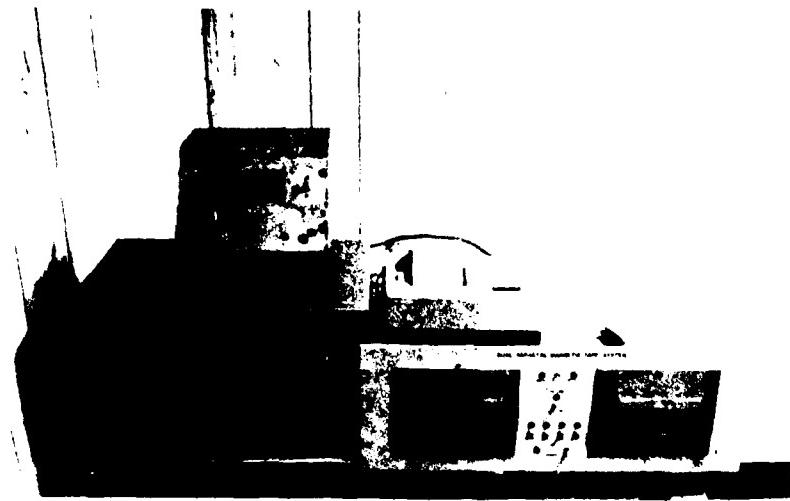


Figure 14. Salinity data logger

is read from an analog meter. Analog meters provide much opportunity for error in reading and transcription, and even the most experienced operators are unable to be more accurate than 2 percent of full scale, which is 0.8 ppt. The solumeters provide a voltage output of 0 to 100 mv which is proportional to 0 to 100 percent of full scale. This voltage is used to drive a digital voltmeter that measures to within ± 0.1 mv giving a resolution of 0.1 percent of full scale or 0.04 ppt. In calibrating the meters, it was found that a given salinity standard could be repeated to within approximately 0.3 percent or 0.12 ppt. This is in an ideal situation where temperatures, conductivity, and probe residence time are carefully controlled. Other tests performed on the meters indicate that most samples can be relied upon to within approximately 0.5 ppt. There are some cases where operator error or electronic problems can cause larger deviations, but these are detectable and can be isolated from the data set or corrected.

38. The data logging system (Figure 14) used for this study enters the values, converted by the digital voltmeters, on cassette tape in ASCII code where it can be processed by the TI 980 minicomputer for storage. With each sample value, pertinent information such as depth, time, tide, and station name is added to the record. This can all be accomplished with a minimum effort on the part of the meter operator. Direct entry of values on cassette tape precludes the need for keypunching and the possibility of misinterpretation with each transfer to a different medium.

PART III: STEADY-STATE TIDE AND VELOCITY TESTS

Test Conditions

39. The purpose of the steady-state tests in the Norfolk Harbor study was to examine the impact of channel deepening on tidal elevations and current velocities in the lower Chesapeake Bay and James River regions. The data collected from these hydraulic model tests were to be used in numerical hydrodynamic models at WES under a separate agreement with the U. S. Army Engineer District, Norfolk, to study sediment transport and shoaling characteristics of the dredged Norfolk shipping channels and adjacent estuary bed areas. The proposed improvements to Norfolk Harbor and its approach channels are described in PART I and are shown in Figure 2.

40. The term "steady state" indicates that the hydraulic model was operated under conditions of constant river inflow and a repetitive cosine tide at the model ocean. The testing scheme consisted of a base condition in which the model bathymetry simulated present prototype conditions with the Norfolk channels molded to depths reported from a U. S. Army Corps of Engineers hydrographic survey in 1980, and a plan condition in which the channels were deepened to their proposed project depths plus 3 ft for overdepth dredging. The tide, velocity,* and direction testing for both base and plan conditions was performed under the following four test scenarios:

- Test 1: The model was operated under a repetitive cosine tide varying from +2.40 to -2.40 ft NGVD** at the Atlantic Ocean control station. This approximates a spring tide condition in Chesapeake Bay. The total bay freshwater river inflow was a constant 200,000 cfs which represents a relatively high flooding condition.
- Test 2: The total bay discharge remained at 200,000 cfs; however, the repetitive cosine tide varied from +1.50 to -1.50 ft NGVD which approximates a neap tide condition.
- Test 3: The total bay discharge was 70,000 cfs which simulates the long-term average flow into the Chesapeake Bay from all of

* Velocity can be rigorously defined as a vector quantity containing speed and direction. It is, however, commonly used as a scalar quantity describing current speed in either a flood or ebb direction. Hereafter, velocity will be used as a description of current speed unless otherwise noted.

** All elevations cited herein are in feet referred to the National Geodetic Vertical Datum (NGVD), though on some figures and plates "ft msl" is used.

its tributaries. The approximate spring tide varying from +2.40 to -2.40 ft was generated at the ocean.

Test 4: The total bay discharge remained at 70,000 cfs and the approximate neap tide varying from +1.50 to -1.50 ft was generated at the ocean.

41. Steady-state discharges for each of the 23 model river inflows are summarized in Table 2. In addition to the river inflows, five sewage treatment plants and the Surry Nuclear Power Plant cooling water diversion were operated throughout the four steady-state tests. Locations of the sewage treatment plants and the Surry plant are shown in Figure 5 with their coordinates and steady-state discharge rates given in Table 1.

42. During both the steady-state and dynamic tests, tides were generated only at the Atlantic Ocean boundary. The model is capable of generating tides at the Delaware Bay end of the C&D Canal but this was not done during the Norfolk study. The Delaware Bay tide source is sufficiently distant from the study area to make its inclusion insignificant and certainly not cost-effective.

43. The source salinity for the entire model study was 32.5 ppt. Control of the source salinity during the steady-state tests was considered good with any minor variations being incapable of causing any observable base versus plan differences in tides or velocities. A complete documentation of all model boundary conditions during these tests is available (Waltz and Morton 1982).

Tide Test Data and Results

44. During steady-state testing, model tide observations were made at the 16 stations shown in Figure 15 and at one in the ocean. The 17 stations are listed in Table 3. Tide elevations were recorded hourly (every 36 sec real-time) over two tide cycles or 24.84 prototype equivalent hours. These tide measurements were made both manually using graduated point gages attached to portable tripod supports and automatically using electronic water-level detectors. Data from the water-level detectors were stored on flexible diskettes via the model control computer.

45. Tide station locations were determined by the requirements of the numerical hydrodynamic models to be used in the sediment transport studies at WES. Major boundaries of the two numerical hydrodynamic models were at range

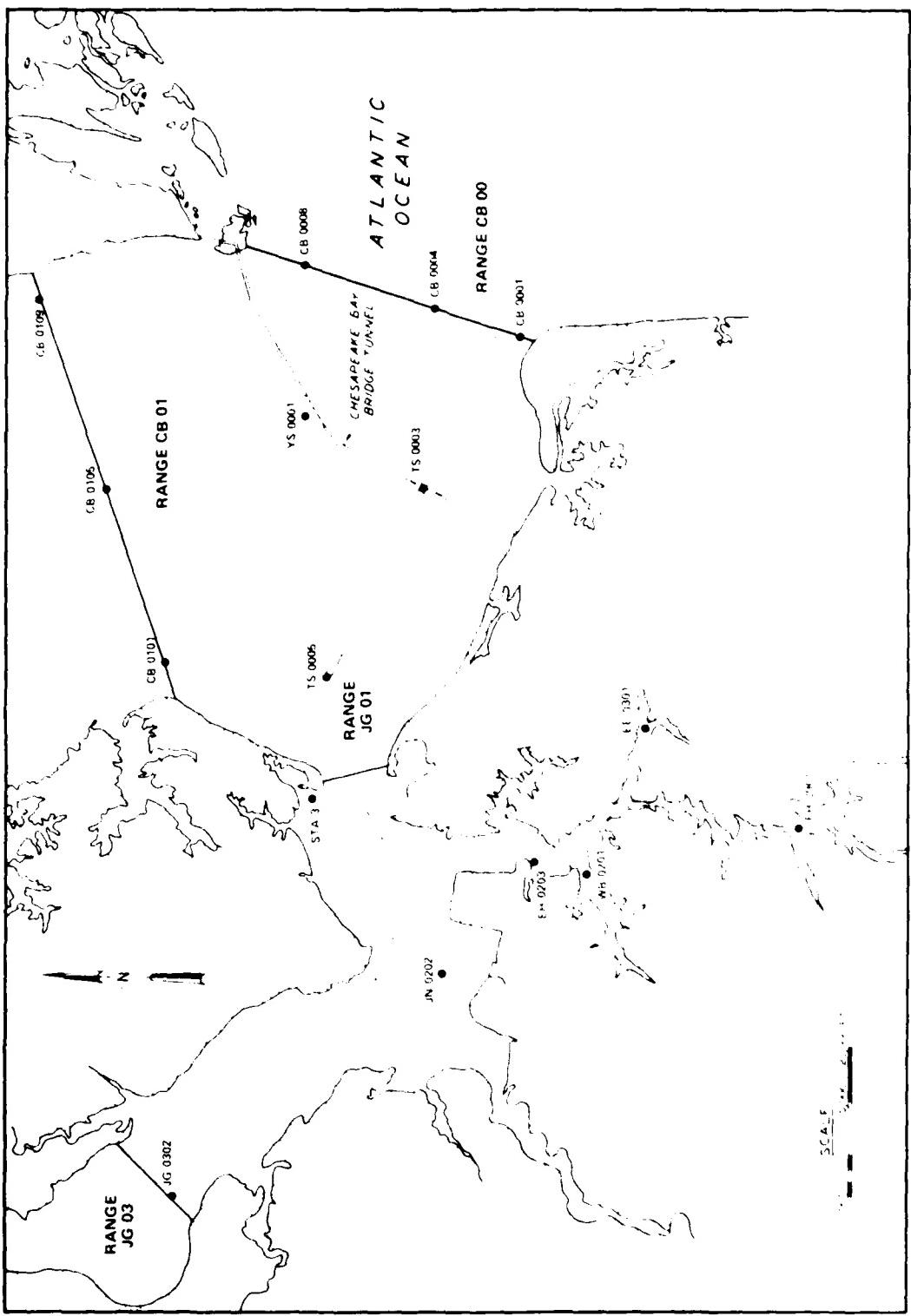


Figure 15. Steady-state manual tide station locations

CB00 on the east, CB01 on the north, range JG01 at the mouth of the James River, and range JG03 at the upstream boundary on the James. To adequately describe cross-sectional water-surface slopes, three tide stations were located across range CB00 at the mouth of Chesapeake Bay, and three stations were positioned across range CB01. Since the James River boundary ranges had relatively short widths, their cross-sectional water-surface slopes were essentially horizontal in the model and could be described by a single tide station.

46. During the base and plan steady-state tests, over 3,400 discrete hourly tide elevation data points were collected from the 17 manual sampling stations. The data set is complete with the exception of sta TS0005 which is missing from base tests 2 and 3. From each station for each test, 25 consecutive hourly tide elevations constituting two complete tidal cycles were fitted to the following expression:

$$h(t) = A_o + a \cos \left(\frac{2\pi wt}{360} - \frac{2\pi\theta}{360} \right) \quad (1)$$

where

$h(t)$ = tide height, ft

t = time, hr

A_o = mean water level, ft, of hourly tides

a = amplitude, ft

$w = M_2$ constituent angular velocity, 28.984104 deg/hr

θ = phase angle or epoch, deg, from zero lunar hour

47. Resulting cosine-fitted curves for the observed tides are shown in Plates 1-17, and the computed mean water level (A_o), amplitude (a), and phase angle (θ) are listed in Tables 4A-4D along with base to plan comparisons. The value, R^2 , shown in Plates 1-112 is a statistic that measures the goodness of fit of the cosine curve through the individual data points with a value of 1.0 being an exact fit.

48. Manual point gages are graduated to 0.001 ft (0.1 ft prototype equivalent) and can be estimated to the nearest 0.0005 ft (0.05 ft prototype). Thus it is reasonable to assume that the accuracy of the manual point gages for a single tide measurement is ± 0.10 ft (prototype) depending upon a number of variables including the keenness of the technician's eye, the delicacy of his or her touch in lowering the point gage to the water surface, and the presence or absence of small water-surface ripples at the instant of measurement.

Accuracy of the computed mean water level and tidal amplitude is therefore also assumed to be ± 0.10 ft (prototype).

49. "Zero-lunar-hour" is the time reference used to ensure that measurements made in the model can be compared with those taken in the prototype. Zero-lunar-hour occurs when the moon is directly over Chesapeake Bay. For the model reverification tests conducted in 1981, the model clock in the ocean tide control hut was set so that zero-lunar-hour occurred at hour 6.6 (191 deg epoch). This same clock setting was also used for both base and plan tests of the Norfolk Harbor study. The procedure for setting the model clock was somewhat subjective. A technician would take a succession of readings at the ocean point gage, the time between readings normally being between 6 and 10 sec (real-time). Upon noticing that the peak of the tidal wave had occurred, the technician would then note the time on the model clock and adjust it to hour 6.6 if necessary. The time lag from the instant of actual tidal peak occurrence to the instant that the technician perceives this peak could be as great as 17 sec (14 deg epoch). In general, no adjustments were made to the clock unless high-water occurrence varied by 0.5 hr or more from the desired hour 6.6.

50. Technicians are cued by a bell timing system which rings for a duration of 10 sec at the start of each prototype hour, and they are instructed to make their tide measurements as near as possible to the beginning of the bell. It is believed that discrepancies in time of measurement could cause as much as an 8-deg error in epoch when considering a discrete tide observation. Hence it is reasonable to assume that the raw model phase angles are accurate to within ± 22 deg.

51. Plan-minus-base amplitude differences for the four tests are summarized in Table 5. Very little change in amplitude was noticed between base and plan tests. From the differences listed in Table 5, one may be able to deduce trends indicating a slight increase in amplitude for the plan condition during Test 1, slight decreases in plan amplitudes during Tests 2 and 3, and essentially no change during Test 4. However, the largest change in amplitude measured in the model was -0.08 ft at sta CB0008 during Test 3. This is within the accuracy limitations of the model; thus any differences listed in Table 5 are considered due to random measurement error inherent in the model and not a result of channel deepening.

52. Plan-minus-base mean water-level differences for all four tests are

summarized in Table 6. Computed mean water-level differences from the manual point gages were nearly uninterpretable due to two problems that existed in the model during testing:

- a. The portable tripods on which the manual point gages were mounted were not stable enough for the degree of accuracy required to interpret base-to-plan mean water-level changes. The procedure for referencing these point gages to a datum involved lowering the point of the gage to a submerged fixed pin whose elevation was known. However, the pressure exerted in touching the point to the pin was apparently great enough in many cases to cause the entire tripod to tilt by as much as 0.30 ft (prototype). This may account for the anomalous values in Table 6.
- b. In the ocean tide hut, the model is controlled by a bubble tube positioner (BTP) and a fixed-point gage housed inside a baffle pit. The main purpose of the baffle pit was to prevent surface waves from interfering with the tide sensing equipment. Prior to the start of the Norfolk Harbor study, this baffle pit was reconstructed using solid barriers to prevent the thin fresh-water lens, which accumulates in the ocean as a result of river inflows, from being sensed by the BTP. This baffle pit, therefore, prevented the horizontal exchange of ocean water on the outside with essentially stagnant water on the inside. Near the completion of the plan test, an experiment was performed in which it was discovered that the water inside the baffle pit was 4.5 ppt less saline than an equivalent column of ocean water on the outside.

53. The model computer controlled the level in the model so that the mean water level at the ocean station within the baffle pit was 0.00 ft. However, the laws of fluid statics state that existence of a 4.5-ppt density difference will cause the plane of the model outside the baffle pit to be 0.14 ft less than the plane within the baffle pit. The only fixed-point gage other than the ocean station that was monitored during the Norfolk Harbor tests was sta 3 at Old Point Comfort on the James River. It is evident in Table 6 that the plan-minus-base mean water-level difference is -0.14 ft at sta 3 just as the aforementioned experiment concluded. No data are available from the base tests to confirm whether a density difference was present in the ocean baffle pit; however, based on the data from sta 3, it is assumed that no such difference existed at that time. Therefore it is reasonable to treat this as a systematic error and apply an approximate additive correction of +0.14 ft to all base-to-plan mean water-level differences (see adjusted mean water-level differences in Table 6).

54. Although the unstable tripods have created an error which cannot be filtered out of the mean water-level data, it is interesting to note that the

overall average of adjusted mean water-level differences in Table 6 was 0.00 ft for Test 1, +0.06 ft for Test 2, +0.01 ft for Test 3, and -0.05 ft for Test 4. The overall mean of all four tests combined showed a difference of 0.00 ft. Based on these averages, a general inference can be made that on the whole, channel deepening caused no changes in mean water levels in this model study.

55. All phase angles listed in Tables 4A-4D have been normalized to a standard ocean station phase of 191 deg and are summarized in Table 7 along with plan-minus-base differences. By normalizing all phase angles to the ocean station, the error in model control of the occurrence of high water at hour 6.6 has been filtered out of all measurements. Any remaining base-to-plan discrepancies in phase can now be attributed either to the time-of-measurement random sampling error, or to the effects of channel deepening, or a combination of both. Plan-minus-base differences in Table 7 are all within the ± 18 deg time-of-measurement error band. Thus the model evidence indicates that all phase differences are due to random sampling errors rather than the result of deepening Norfolk Harbor and its approach channels.

Velocity Tests

56. Current velocities in the Chesapeake Bay model are largely the result of three factors: tides, freshwater discharges, and salinity density gradients. Of these, the most important factor affecting current velocities is the amplitude of the tide which varies throughout the model depending on the local bathymetry. Freshwater discharge plays a variable role depending upon its magnitude and the estuary cross-sectional geometry, the most significant effect being in the upper reaches of tributaries. Existence of a salinity density gradient causes a multilayer flow system to be formed in which the denser bottom water tends to move predominantly in the flood direction (upstream) while the fresher surface layer flows mainly in the ebb direction (downstream).

57. Model velocities were measured at 32 sampling stations during the four steady-state tests. Velocity observations were collected concurrently with the tide elevations discussed in the previous section. In addition, current direction data were collected at 26 of the velocity sampling stations. Six stations (EH 0203, 0501, 0701, 0901, EE 0301, and WB 0201) were located in constricted channel areas where direction measurements were unnecessary. Locations of the velocity stations are shown in Figure 16 and are listed in Table 8.

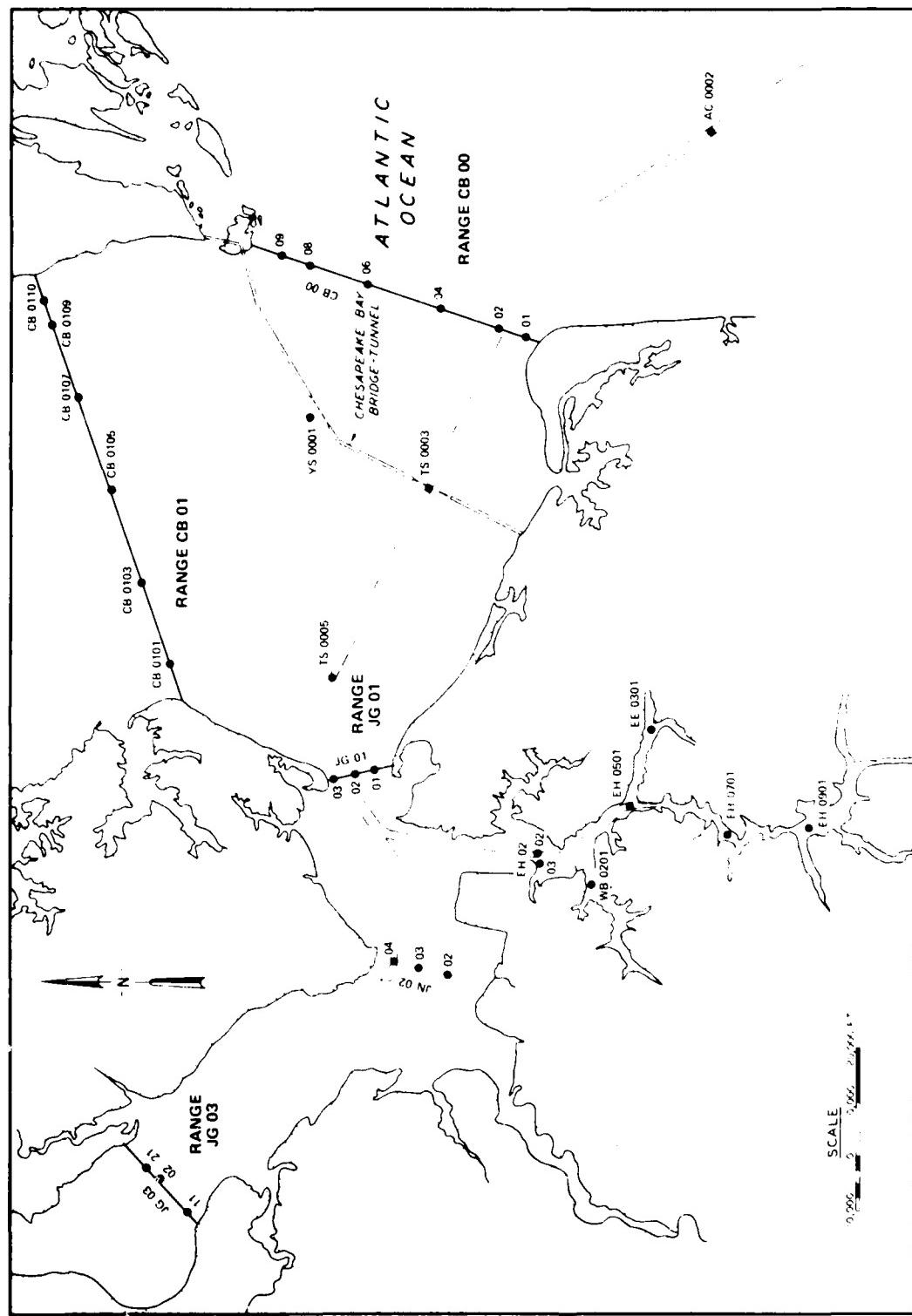


Figure 16. Steady-state velocity stations

58. Station locations were determined primarily by boundary requirements of the numerical hydrodynamic and sediment transport models at WES. Velocities were sampled across ranges CB00, CB01, JG01, and JG03 which defined transverse boundaries in the mathematical models. Additional samples were taken in the Norfolk approach channels and in the Elizabeth River and its tributaries. Depending upon total station depth, velocities and directions were generally sampled at the surface, middle, and bottom. At stations located within the Norfolk approach channels, velocities were collected at coincident depths for both base and plan channel configurations with an additional deeper bottom depth sampled during the plan test (Figure 17).

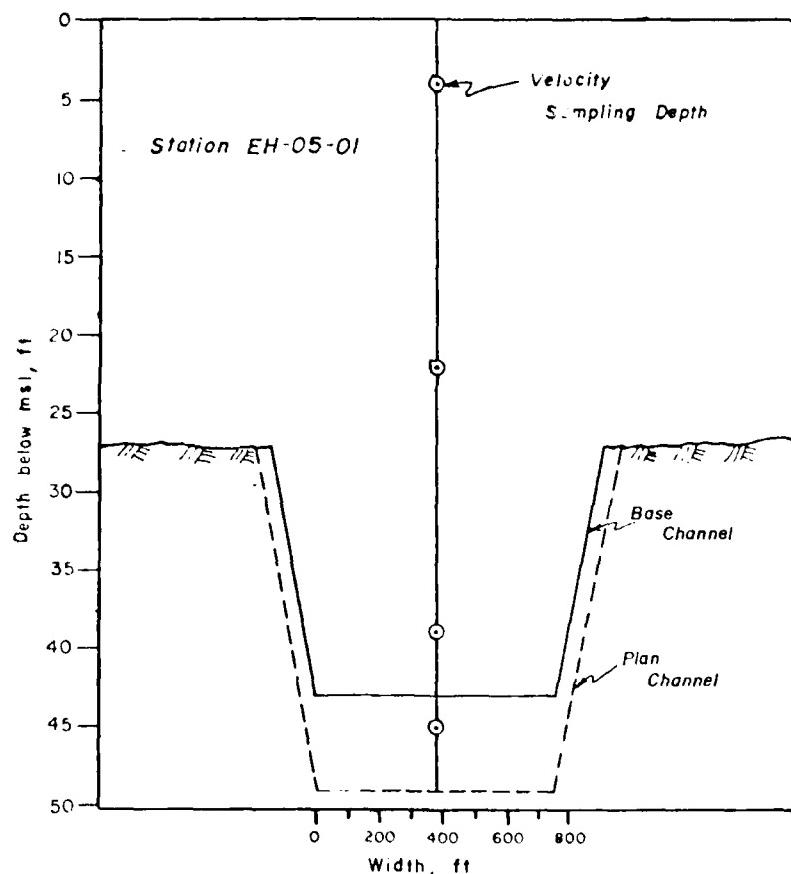


Figure 17. Typical velocity sampling scheme

59. The testing equipment included miniature Price-type velocity meters and a small direction vane, both of which are discussed in PART II. Velocity magnitude and direction measurements were recorded every hour (36 sec

(real-time) for two tide cycles at each sampling depth. Each velocity meter had a unique calibration equation which related the current velocity (prototype fps) to the number of revolutions traveled by the meter cups in a 10-sec interval (real-time). Each meter also had a so-called "threshold-of-motion" defined as a critical velocity less than which the meter would cease to turn. At velocities less than critical, the momentum of the moving water was not great enough to overcome the inertial and frictional forces of the meter. The threshold-of-motion varied from meter to meter and was generally 0.30 fps (prototype equivalent) or less.

60. Uncertainty in model velocity measurements results from errors falling into the following three classes:

- a. Boundary condition errors--These are caused by variations in source salinity, tide control, river discharge control, and local perturbations in the flow field.
- b. Instrument errors--These result from imperfections in the manufacture and calibration of the velocity meters. As an example, the mechanical cups of a meter may not be centered symmetrically about its axis causing an irregular rotation even though the actual current may be steady and uniform.
- c. Personal errors--These errors stem from limitations of the human senses of sight, touch, and hearing, all of which are used during velocity testing.

Three of the boundary condition errors (source salinity, tide control, and river discharge) were maintained within acceptable limits throughout the steady-state testing; and the recorded variations will have a negligible effect on the reliability of current velocities. Local perturbations in the flow field are random natural errors and tend to cancel out with a large number of observations. Instrument errors were minimized by screening all available velocity meters in the initial calibration process and choosing for testing purposes only those exhibiting the highest quality. The calibration of each meter was checked at least once a day in the laboratory flume. The calibration equations are accurate to within approximately ± 0.15 fps based on 95 percent confidence interval with 47 degrees of freedom. The most significant personal error introduced into the velocity measurements was in estimating the fractions of a revolution that a meter turns. This can be reasonably estimated to the nearest 0.2 revolutions or about ± 0.15 fps. Thus, considering all the sources of possible error, the accuracy of a discrete model velocity measurement is approximately ± 0.30 fps (prototype equivalent).

61. The frontal dimension of one velocity meter cup is 0.04 ft (actual) in diameter and has an area of 0.001265 sq ft. Due to the distorted scale of the model, this corresponds to an equivalent prototype area of 126.5 sq ft in the shape of an ellipse having a semimajor horizontal axis of 200 ft and a semiminor vertical axis of 2 ft. Because of this scale effect, velocities measured in the model cannot be interpreted as equivalent prototype point velocities; instead, they correspond to prototype velocities averaged over the area of the equivalent ellipse.

Velocity Data Analysis

62. Over 32,000 discrete velocity and direction measurements were recorded during the base and plan tests. At each sampling depth, 25 consecutive hourly velocity observations constituting two tidal cycles were fitted to the following equation using a harmonic least squares curve fitting technique.

$$v(t) = U_o + u \cos \left(\frac{2\pi\omega t}{360} - \frac{2\pi\theta}{360} \right) \quad (2)$$

where

$v(t)$ = current velocity, fps

t = time, hr

U_o = mean velocity, fps of the hourly observations

u = amplitude, fps

ω = M_2 constituent angular velocity, 28.984104 deg/hr

θ = phase angle, deg

The confidence of the computed velocity constants (phase (θ), amplitude (u), and mean (U_o)) is generally greater than that of a discrete measurement since all 25 hourly observations are used in the analysis. The velocity constants are relatively insensitive to a few outliers.

63. Individual velocity observations and cosine-fitted curves for both the base and plan conditions are shown in Plates 18-112. Velocity constants are listed in Tables 9A-9D. Plan-minus-base differences in the velocity constants for the four steady-state tests and summary statistics are given in Tables 10A-10D.

64. The inertial and frictional forces inherent in the velocity meters introduce relatively large instrument errors at low current velocities;

however, as the current speed increases these instrument errors decrease. Thus a higher degree of confidence can be placed in the discrete maximum flood and maximum ebb velocities measured in the model such that plan-to-base comparisons are meaningful. Each set of 25 hourly velocities contained two maximum flood and two maximum ebb velocity measurements. These two maximums were averaged and are listed in Tables 11A-11D under the "MODEL DATA" heading. Also, maximum flood and ebb velocities computed from the harmonic Fourier analysis are given in Tables 11A-11D under the "HARMONIC ANALYSIS" heading. Plan-minus-base maximum flood and ebb differences and summary statistics are given in Tables 12A-12F. Plates 113-144 show the maximum flood and ebb velocity profiles for both the base and plan tests.

65. The concept of flow predominance is useful in analyzing the effects of density-induced currents on velocities. Consider the conventional velocity versus time plot in Figure 18. The shaded area under the ebb portion of the curve is divided by the sum of the areas under the ebb curve and flood curve. The result is called the flow predominance and is defined as the percent of the total flow per tide cycle that is moving in the ebb direction at a given velocity sampling depth. In a partly mixed estuary such as Chesapeake Bay, the bottom flow predominance will be mainly in the flood direction within the salinity wedge, and the surface flow predominance will be in the ebb

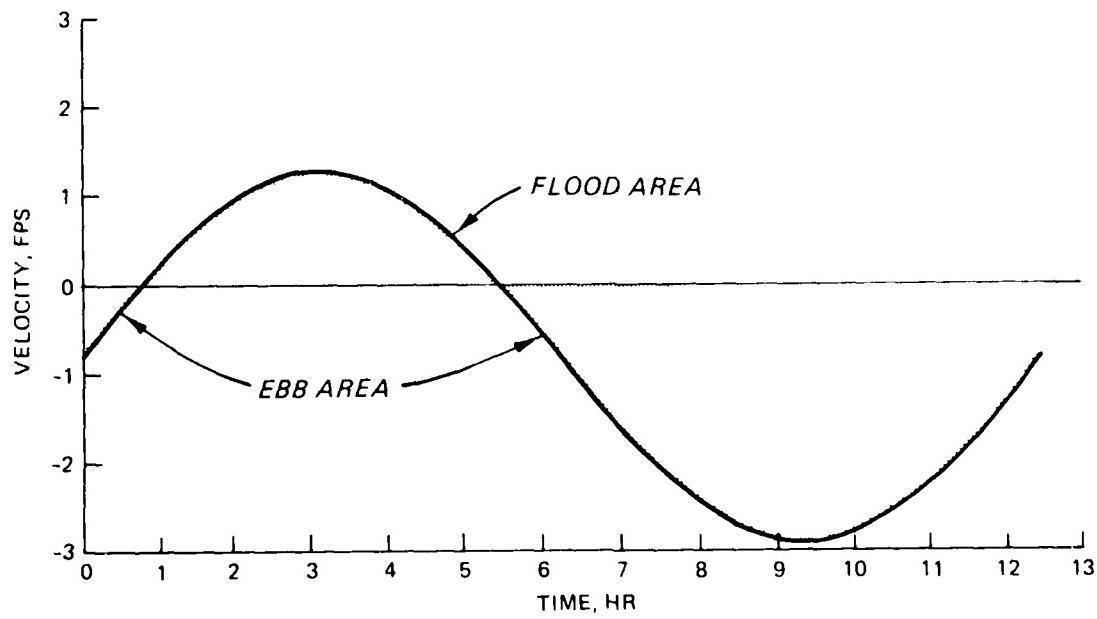


Figure 18. Definition sketch: flow predominance

direction. The flow predominance percentages for the four steady-state tests along with plan-minus-base differences and summary statistics are listed in Tables 13A-13B.

Velocity Test Results

Plan-to-base velocity phase comparisons

66. Current velocity phase is the time (in degrees) of maximum flood velocity referenced to zero-lunar-hour. A complete tidal cycle in the model is 12.4206 model hours (360 deg) in length. The confidence of velocity phasing is approximately ± 20 deg. Frequency-of-occurrence statistics of plan-minus-base phase differences are provided in Table 10B. Nearly 30 percent of the plan and base values were within 5 deg of one another, 67 percent were within 10 deg, nearly 87 percent were within 15 deg, and nearly 97 percent were within the 20-deg confidence band. Table 10A shows that during Test 1 the plan phase occurs 64 deg prior to the base phase at sta JG0103 at depth 83 ft. A velocity meter problem was evident during the base test and this phase value should not be considered. Also, at sta EH0901 and depth 35 ft during Test 2 and at sta EE0301 and depth 21 ft during Test 4 the velocities were so low that threshold-of-motion problems were experienced resulting in anomalous phasing. Only 10 (2.9 percent) phase discrepancies fall outside the 20-deg confidence band with all but one occurring in the Elizabeth River at sta EH0202, EH0203, and EH0501. It appears that the deepened Elizabeth River channel with its larger cross-sectional area reduced velocities sufficiently to cause the velocity meters to occasionally operate within their threshold-of-motion ranges resulting in the anomalous data. Thus any phase differences outside the ± 20 deg confidence band should be viewed with reservation.

67. The conclusion is that channel deepening has caused only minimal phasing differences between base and plan tests. The only sampling depth at which a phase difference trend seemed evident was at sta EH0501, depth 39 ft, which is at the confluence of the Eastern and Southern Branches of the Elizabeth River. Here the plan phase consistently arrived earlier than the base phase.

Plan-to-base velocity amplitude comparisons

68. Current velocity amplitudes are defined as one-half of the range

between the maximum flood and maximum ebb velocities from the cosine fit curve. All 25 hourly velocity observations are taken into account in the amplitude computations, so greater confidence can be placed in the amplitude values than in a discrete velocity observation. Frequency-of-occurrence statistics of plan-minus-base amplitude differences are given in Table 10C. Over 27 percent of the base and plan velocity amplitudes were within 0.10 fps of one another, over 52 percent were within 0.20 fps, over 73 percent were within 0.30 fps, and about 84 percent were within 0.40 fps. There was an overall trend toward decreased amplitudes in the plan test. Of the 347 amplitude difference values, 97 (28 percent) were greater than 0.00 fps while 250 (72 percent) were less than 0.00 fps. The overall mean of the amplitude differences indicated a 0.13-fps decrease in the plan test. This decrease in velocity amplitude in the plan test meets the expectancy associated with deepened channels and the resulting larger cross-sectional areas.

69. Anomalous amplitude values are evident at sta CB0008 and sta JG0103, depths 66 and 83 ft, respectively, during base Test 1 and should not be considered due to meter instrument errors. The largest plan-to-base decreases in amplitude are between 0.80 and 1.00 fps and occur during Test 1 (200,000-cts discharge with spring tides) at sta JG0102, EH0202, and EH0203. The largest plan-to-base increases in amplitude are 0.56 fps at sta CB0006, depth 4 ft, during Test 1 and 0.51 fps at sta YS0001, depth 25 ft, during Test 2.

70. By inspection of Tables 10A, 10B, and 10C, trends can be seen in the amplitude changes due to channel deepening without regard to a specific freshwater discharge or tide range. On the average, the stations on range CB00 show plan-to-base decreases in amplitude with the exception of CB0004 and CB0006 which show slight increases. An overall decrease in amplitude in the plan test is also evident across range CB01 with the exception of the surface depth at CB0109. Sta AC0002 shows an amplitude decrease at the surface and middle while the bottom amplitudes remained essentially the same in the plan tests. Sta YS0001 shows an amplitude decrease at the surface and averages essentially no change at the middle and bottom. Sta TS0003 indicates a decrease in surface and middle amplitudes and essentially no change at the bottom. Sta TS0005 indicates a decrease at the surface, no change in the middle, and an increase at the bottom. Interestingly, the entrance to the James River at range JG01 shows plan decreases in amplitude at the out-of-channel stations while the deep natural channel sta JG0103 shows an increase in amplitude at

the three lower depths. Apparently, the deepened Norfolk channels have caused a redistribution of the flow pattern at the mouth of the James. The other two James ranges, JN02 and JG03, show slight decreases in amplitude essentially across both ranges. The stations in the Elizabeth River and its tributaries all show decreases in plan amplitudes except the bottom depths at sta EH0501 and EH0901 which indicate essentially no change from base to plan.

Plan-to-base mean velocity comparisons

71. The mean current velocity is simply the mean of the 25 hourly velocity measurements at a given sampling depth. The mean velocity gives an indication of flow predominance, positive being flood predominance and negative being ebb predominance. The frequency-of-occurrence statistics of plan-minus-base mean velocity differences are listed in Table 10D. More than 60 percent of the base and plan mean velocities were within 0.10 fps of one another, over 86 percent were within 0.20 fps, nearly 95 percent were within 0.30 fps, and over 97 percent were within 0.40 fps. The mean of these differences for each of the four steady-state tests was close to 0.00 fps as was the overall mean of the entire data set. This indicates that channel deepening had little impact on the mean current velocities when the entire data set is considered.

72. The average overall plan-minus-base mean velocity differences at each sampling depth for the four tests are given in Table 10D. Inspection of Table 10A shows that sampling points at which the mean velocity increased with channel deepening during all four tests are:

CB0001 Depth 4 ft
TS0003 Depths 4 and 46 ft
JG0103 Depths 22 and 66 ft
JN0204 Depth 48 ft
EH0701 Depth 4 ft

Sampling points showing a decrease in plan mean velocity for all four tests are:

CB0004 Depth 4 ft
TS0005 Depth 50 ft
EH0202 Depth 46 ft

All other stations show either essentially no change from base-to-plan conditions or an increase during one test and a decrease in another.

Plan-to-base maximum flood
and ebb velocity comparisons

73. Since the maximum flood and ebb velocities are normally well outside the threshold-of-motion range, a high degree of confidence can be placed on these measurements making plan-to-base comparisons meaningful. The plan-minus-base maximum flood and ebb velocity differences are presented in two forms: (a) the differences using discrete model measurements are given in Table 12A, and (b) the differences using the peaks of the harmonic cosine-fit curve are given in Table 12B. Anomalous data at sta CB008, all depths, and JG0103, depth 83 ft, during Test 1 were not considered in the analyses.

74. From the frequency-of-occurrence statistics in Tables 12C-12F, the following summary of the overall data set shows the percent occurrence within certain intervals:

Interval	Maximum Flood percent		Maximum Ebb percent	
	Model Data	Cosine- Fit Data	Model Data	Cosine- Fit Data
Plan and base within 0.10 fps	27.9	29.9	21.3	22.3
Plan and base within 0.20 fps	51.5	55.2	42.9	46.3
Plan and base within 0.30 fps	69.3	72.7	61.7	62.3
Plan and base within 0.40 fps	81.9	84.4	73.8	76.6

When considering overall averages from the four tests, the prevailing trend indicates that the maximum flood and ebb velocities decrease by approximately 0.10 fps after channel deepening. The largest average change was during Test 4 (70,000-cfs discharge with neap tide range) where plan maximum flood and ebb velocities decreased about 0.20 fps. The overall maximum flood and ebb velocity magnitudes were reduced slightly because of the increase in cross-sectional area associated with the deeper plan channels.

75. Plates 113-144 show two sets of maximum flood and ebb velocity profiles for each steady-state test at each station. One set is labeled "model data" and represents the actual maximum flood and ebb velocities measured in the model. The other set is labeled "harmonic data" and represents the maximum flood and ebb velocities taken from the harmonic cosine-fit curve resulting from the harmonic analysis of the 25 hourly velocity observations. Most often the model and harmonic profiles are in agreement. However, there are

times when the harmonic profile shows better plan-to-base agreement than does the model data profile (e.g., see the ebb profile for sta TS0005 during Test 2 in Plate 127). Likewise, there are occasions when the model data profile shows slightly better plan-to-base agreement than does the harmonic profile (e.g., see the ebb profile for sta CB0008 during Test 2 in Plate 117). Both sets of velocity profiles were given equal weight and were used as references to formulate the following specific comments:

- a. The maximum flood and ebb velocities at range CB00 for both base and plan conditions were essentially the same with the exception of sta CB0002 which shows lower ebb velocities during the plan Tests 1 and 2 (200,000-cfs discharge), sta CB0004 which showed increased flood and ebb during Test 2 and sta CB0008 which showed reduced flood and ebb during Test 4. Decreases in plan maximum velocities can be seen at sta CB0009.
- b. Across range CB01, the overall trend was for maximum flood and ebb velocities to decrease slightly along the western half of the range and remain essentially the same along the eastern half during the plan test.
- c. At sta AC0002, the effects of the new Atlantic Ocean channel can be clearly seen in Plate 125. The deepened channel with its larger cross-sectional area causes a decrease in plan velocities at the surface and middle depths.
- d. At sta TS0003, the plan maximum ebb velocities tend to decrease at the surface while the flood velocities show little change except during Tests 1 and 4 where there is a decrease of about 0.40 fps at the surface and middle depths. At TS0005, the maximum velocity profiles are essentially the same from base-to-plan conditions except for the middle depth during Test 4 which becomes more flood predominant.
- e. At the mouth of the James River, sta JG0101 and JG0102 both indicate a general decrease in maximum velocities of about 0.20 to 1.00 fps. Sta JG0103 (Plate 131) contains anomalous data at depth 83 ft during base Test 1; however, there is an indication of increased velocities at bottom depths during the spring tide range (Tests 1 and 3) while the entire velocity profile remains unchanged during neap tides (Tests 2 and 4).
- f. At JN0204, which is stationed within the deepened Norfolk Harbor Channel, a decrease of about 0.40 fps occurs generally throughout the entire velocity profile during Test 3 while an increase of about 0.50 fps in surface ebb is apparent during Test 1 with a lower increase for Test 2.
- g. Sta JG0302 is interesting because a 0.20- to 1.00-fps decrease is evident throughout the plan flood and ebb velocity profiles during Tests 3 and 4 (70,000-cfs discharge). However, there is an increase of about 0.35 fps throughout the entire flood and ebb profile during Test 1. Test 2 shows essentially no change.

- h. Sta EH0202 is another good example showing how channel deepening causes a decrease in velocities within the channel (the base velocities during Test 2, however, appear to be within the threshold-of-motion range of the velocity meter and should not be considered). All velocity stations within the deepened Elizabeth River channel show a general decrease in maximum flood and ebb velocities of 0.10 to 0.40 fps throughout the vertical profile.

Plan-to-base flow predominance comparisons

76. Flow predominance values are given in percent of flow in the ebb direction in Table 13A. Frequency-of-occurrence statistics for plan-minus-base flow predominance differences are given in Table 13B. Overall, about 66 percent of the differences were within 5 percent, over 83 percent were within 10 percent, about 92 percent were within 15 percent, and nearly 97 percent were within 20 percent. The overall mean difference was -0.57 percent. Tests 1 and 2 with the high 200,000-cfs discharge show slightly overall increased ebb predominance during the plan conditions while Tests 3 and 4 with the lower 70,000-cfs discharge indicate that channel deepening will decrease ebb predominance slightly. It should be mentioned, however, that the sampling stations represent a finite number of points and do not portray the entire cross section. Other stations across the section, if they were sampled, might have refuted these observations.

77. A more general conception of flow conditions in the James River and Elizabeth River is shown in Figures 19 and 20 where surface and bottom flow predominance profiles have been plotted along the estuary channels. Plan-versus-base changes are subtle in the James River, normally not varying by more than 5 or 10 percent; however, consistent trends are evident. Plan-versus-base variations in the flow predominance profile are more apparent in the Elizabeth River. However, it must be remembered that velocity meters were operating near the threshold-of-motion range, so less confidence can be placed in the Elizabeth River measurements. Again, consistent trends are evident.

78. Saltwater intrusion is important to estuary sedimentation because saline water causes flocculation of suspended clay particles and density currents tend to move sediments upstream along the bottom. Thus sediments entering the estuary may become trapped instead of moving back out to sea. Frequently, the heaviest shoaling occurs between the high-water and low-water

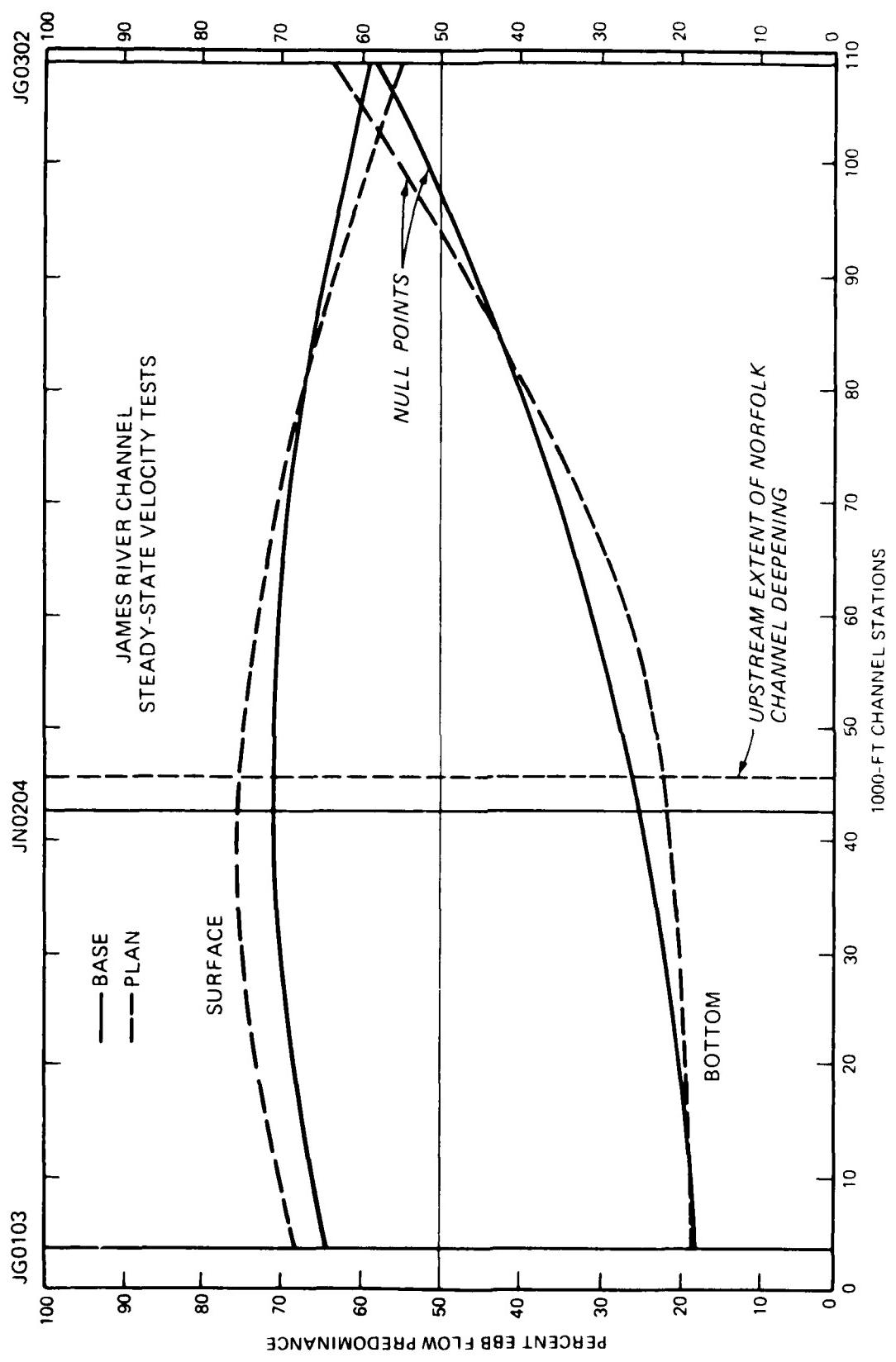


Figure 19. Flow predominance along the lower James River channel

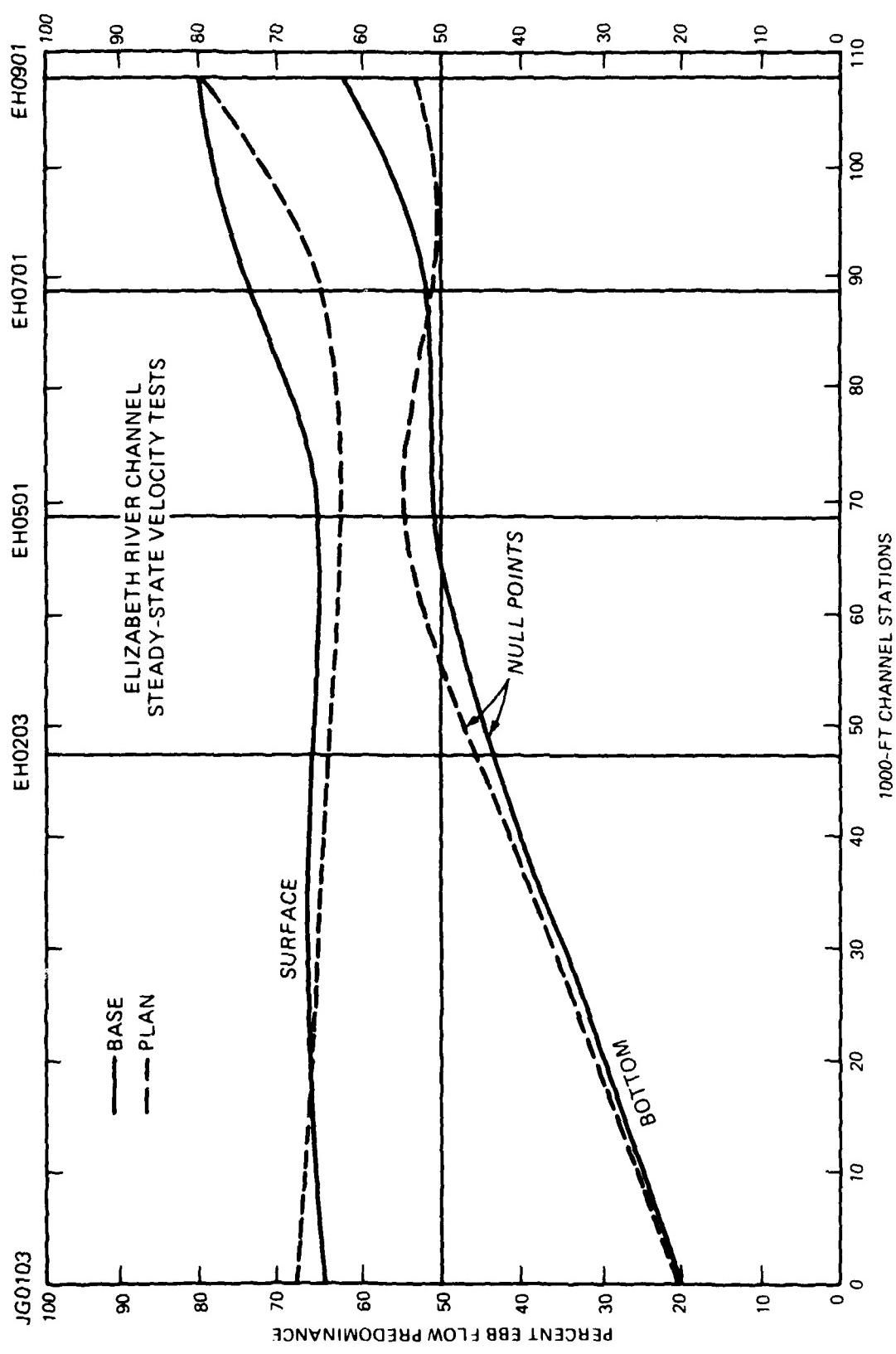


Figure 20. Flow predominance along the Elizabeth River channel

positions of the upstream limit of salinity intrusion. Although shoaling depends largely on the ability of bottom currents to move bed materials upstream, the most likely region in which the heaviest shoaling will occur is the reach bracketing the 50 percent value (or null point) on the bottom flow predominance profile (Schultz and Simmons 1957). In both the James and Elizabeth Rivers, the location of this null point remains basically the same from base-to-plan conditions. Hence, channel deepening should not change the present locations of the heaviest shoaling in the James and Elizabeth Rivers. On the other hand, there are several isolated instances where the plan condition reversed the direction of bottom flow predominance. This should indicate a significant change in local shoaling during those particular flow and tide conditions. However, this model study cannot directly predict whether the magnitude of shoaling will change with channel deepening. It is important to understand that the locations of these heavy shoaling areas cannot be pinpointed exactly in the model and are only "best guess" interpretations of model velocity measurements. In order to determine shoaling locations more accurately, a more dense velocity sampling network would be necessary. The velocity sampling scheme used in this study was primarily determined by the requirements of the numerical hydrodynamic models that will perform a much more rigorous sedimentation and shoaling analysis than was presented herein.

Tide and Velocity Summary

79. Any changes in tide elevations, amplitudes, and phasing due to channel deepening were sufficiently small that they remained undetectable with the measurement techniques used at the hydraulic model.

80. Several subtle velocity variations in the model tests were apparently due to channel deepening. An overall average decrease in velocity amplitude of about 0.13 fps was observed in the plan test. This decrease is consistent with the principle of continuity which states that for a given flow rate the velocity will vary inversely with the cross-sectional area. Similarly, the maximum flood and ebb velocities tend to decrease by approximately 0.10 fps on the average during the plan test. During the high discharge tests, the overall ebb predominance increased slightly. During the 70,000-cfs discharge tests, which represent the long-term average annual flow into Chesapeake Bay, the overall ebb predominance decreased slightly. But it must be

remembered that more than one-third of the velocity stations in this study were located in the channels, so they would feel the impact of salinity intrusion more than the shallow-water stations and would also tend to bias the overall flow predominance mean differences referred to in Table 13B. Hence, no firm conclusions concerning salinity intrusion into the estuary can be made from the velocity data. Deepening the Norfolk channels should not affect the present location of heaviest shoaling in the James and Elizabeth channels, based on the limited number of sampling stations used in this study.

PART IV: DYNAMIC SALINITY TESTING

Test Conditions

81. Dynamic salinity testing for the Norfolk Harbor study was designed so that model response to base and plan geometries could be simulated for a range of naturally occurring prototype conditions. The salinity structure of the prototype, particularly in the lower bay and James River area, is sensitive to a number of boundary conditions that can be simulated in the model. The two most important conditions are the highly variable nature of freshwater input and the cyclical neap-to-spring variations in the tides.

82. The effect of freshwater input on partially mixed estuaries is well documented in the literature. Simply stated, it has been shown in numerous estuaries that increasing freshwater input upstream tends to stratify the estuary given constant tidal conditions, while decreasing inflows provides a homogenizing effect. If the degree of stratification is not altered drastically, an increase in freshwater inflow reduces the upstream extent of saltwater intrusion and vice versa. Tidal influence on salinity structure has also been studied in the past but generally in a steady-state fashion by observing different constant amplitude tides that typify maximum and minimum variations in the tidal record.

83. However, the prototype tide record in Chesapeake Bay, as well as its other estuaries, does not consist of a series of constant amplitude tides. Tides in the Chesapeake show strong neap and spring variations as well as smaller semidiurnal differences in tide heights. The effect of this tidal variability on salinity structure was thought to be important for some time but there has been very little substantiation in the literature. The most notable prototype studies to date discussing this phenomenon are from Haas (1977) and Allen et al. (1980).

84. Haas' study area was the lower York and Rappahannock Rivers in Virginia where he found strong correlations between salinity stratification and the neap-spring tide cycle. Allen's studies were primarily confined to macrotidal estuaries in France, but his observations do support the importance of the neap-spring tide cycle on salinity structure.

85. There have been model studies that have confirmed the importance of the neap-spring cycle on salinity. Physical model studies by Richards and

Gulbrandsen (1982) and Granat and Gulbrandsen (1982) document the existence of structural salinity changes at various stations throughout Chesapeake Bay. These changes seem to be strongest in the lower bay and James River areas.

86. Ample evidence exists, therefore, to suggest that dynamic tidal and freshwater inputs are necessary to approximate prototype responses to base and plan geometries in the Norfolk Harbor areas. The Norfolk Harbor study simulated variable prototype conditions by using a 2-1/2-year weekly stepped hydrograph and a repetitive 28-lunar-day (56 cycle) variable tide. The source salinity for the model study for ease of duplication in both tests was held constant at 32.5 ppt which is appropriate for the historical drought hydrograph used. A more detailed discussion of test boundary conditions follows.

Tides

87. Source (ocean) tides used in the Norfolk Harbor study consisted of a repetitive, 28-lunar-day, 56-cycle tide sequence. The 12 harmonic constituents used to construct the tide were based on coefficients used by NOAA to predict tides at Old Point Comfort, Virginia. Once the desired tide for Old Point Comfort had been determined, it was necessary to adjust the amplitudes and phases to obtain values for the ocean source tide generated some 30 miles offshore. The ocean tide is based on the equation:

$$h(t) = A_o + \sum_{i=1}^{12} \left[a_i \cos \left(\frac{2\pi}{T_i} t - \phi_i \right) \right] \quad (3)$$

where

$h(t)$ = tide height

A_o = mean water level = -0.20 ft NGVD

a_i = constituent amplitude, ft

t = time, hr

T_i = constituent period, hr

ϕ_i = constituent phase, rad

The following are the constituent values:

No.	Constituent	Amplitude, a	Period, T	Phase, ϕ
1	M2	1.426	12.4206	2.3457
2	S2	0.276	12.0000	2.7975
3	N2	0.318	12.6584	1.9627
4	K1	0.204	23.9344	0.0743

(Continued)

No.	Constituent	Amplitude, a	Period, T	Phase, ϕ
5	O1	0.175	25.8194	0.4567
6	V2	0.061	12.6260	2.0553
7	M1	0.007	24.8332	0.3994
8	J1	0.014	23.0985	0.1355
9	Q1	0.024	26.8683	5.9859
10	P1	0.058	24.0659	0.3555
11	L2	0.040	12.1916	2.5059
12	K2	0.071	11.9672	2.6338

Example tide ranges for the source tide include 4.8 ft for tide 1, the largest spring tide, and 2.6 ft for tide 48, a smaller neap tide.

88. Figure 21 is a graphic representation of the 56-cycle tide computed from the above constituents. It contains the spring and neap tide variations and the semidiurnal inequalities noted in prototype tide records. As in the prototype, the tide is propagated up the bay and reaches Reedy Point, Delaware, at the Delaware River end of the C&D Canal approximately 16.16 hr later.

89. Prior to the start of the test, a brief lead-in period of constant tide amplitude is necessary to adjust the ocean tide control amplifier. The range of this lead-in tide reflects the values of tide 1. Once the tide amplifier had been calibrated for the lead-in tide, the variable tide was started and along with a constant discharge condition the model was brought to a state of stable density equilibrium. Upon reaching density equilibrium, the test hydrograph was started and variable tides were maintained throughout the test.

90. The strict control of boundary and initial conditions in a physical model test is of primary importance if any degree of confidence is to be attached to the results. This is especially true for base versus plan testing where model response should be related entirely to designed base versus plan changes (e.g., deepened channels) rather than any fluctuations in boundary conditions.

91. To ensure source tide integrity in both base and plan tests, the ocean tide is monitored continuously by a WLD that is hard-wired to the computer and a strip chart recorder for real-time observation. In addition, manual point gage measurements were taken twice per 56-cycle period on tides 7 and 8 and on tides 35 and 36 to confirm water levels indicated by electronic measurements.

92. The Delaware Bay source tide was not used in these tests for two reasons. First, available prototype data are inadequate to define the amplitudes and periods of the source tide and salinity under variable tidal

ATLANTIC OCEAN SOURCE TIDE
FROM 12 CONSTITUENT HARMONIC ANALYSIS

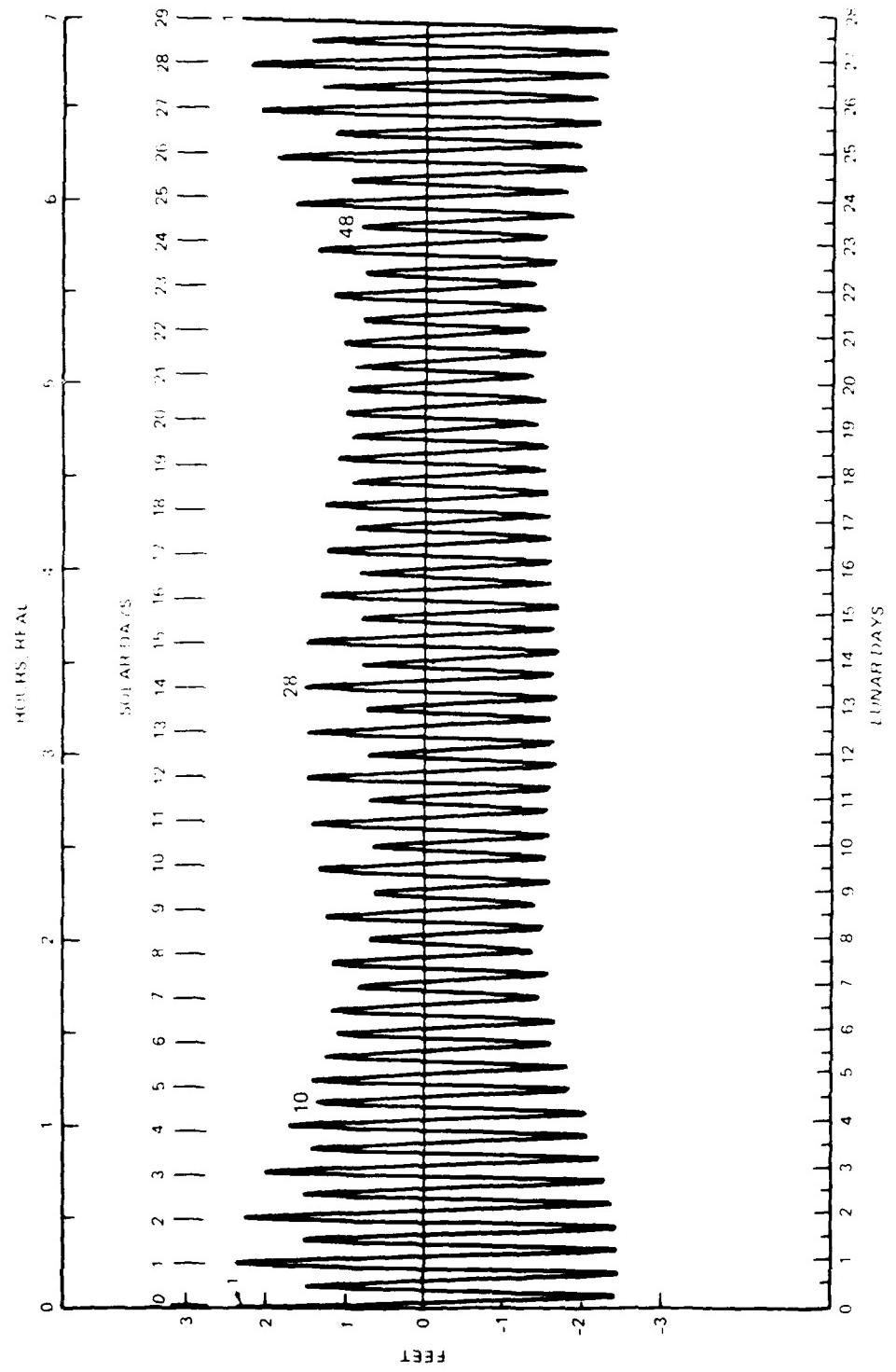


Figure 21. Ocean source variable tide showing tides 1, 10, 28, and 48

conditions in Chesapeake and Delaware Bays. Second, previous testing in the model had shown that the hydrodynamics of the C&D Canal are very sensitive, particularly to variations in mean water-surface elevation, so that even minor discrepancies in boundary control of water-surface elevations have significant impact on canal hydrodynamics and thus on salinities in the Upper Bay. Since boundary control for the source tide in Delaware Bay was not capable of preventing small discrepancies in water-surface elevations, it was decided not to reproduce the source tide for these tests so that any changes in Upper Bay salinities from the base test to the future test would not be erroneously affected by possible discrepancies in boundary control.

Freshwater inflow

93. The Norfolk Harbor test hydrograph consisted of two parts. First, there was a lead-in period (weeks 1-15) of constant discharge that reflected an average total bay discharge of 70,000 cfs. The second period (weeks 16-136) depicted weekly averaged prototype conditions between 24 May 1963 and 17 August 1965. Hydrograph plots for the total bay discharge along with the five rivers closest to the subject area are shown in Plates 145-150.

94. The 15-week constant discharge period was used to observe model stability prior to starting the historical hydrograph and salinity sampling. The ensuing historical hydrograph was used because it was an available data set and had been used largely on other Chesapeake Bay Model tests. As a whole, it reflects a period of relatively low to drought conditions on the bay. This should be considered when analyzing the data. The hydrograph does, however, have sufficiently seasonal variations in discharge to be useful.

Source salinity

95. Source salinity is defined as the salinity of supply water as it enters the headbay at the ocean. This definition was chosen to facilitate sampling and control of salinity. During varying freshwater discharges, the mixing of fresh and salt water in the model ocean causes discontinuous and variable salinities in the vicinity of the headbay. Sampling in this area can yield large changes in salinity over relatively short periods of time, especially during high freshwater discharge periods. The supply sump is a large and nearly homogeneous volume of water (analogous to the prototype ocean) that reacts slowly to a spiked hydrograph; thus it can be measured less often and with greater confidence in a single set of measurements. Salinity samples were taken hourly (4.17 prototype days) in the headbay, in the return sump, and in

the supply sump throughout each dynamic salinity test. Testing of the three areas together helps project trends in the source salinity, and thus large drops in source salinity can be prevented by adding brine to the return sump when it shows a decline. Source salinity was kept to within ± 0.5 ppt of the desired 32.5 ppt throughout both base and plan tests.

96. Sump control in general was considered good for both tests. There were short-term deviations caused by response to freshwater inflow fluctuations in both tests and did not create perceptible discrepancies in the bay salinities. The supply sump source salinity was checked a total of 269 times coincident to both base and plan tests from lunar day -146 to lunar day 933. The base and plan source salinities were within ± 0.2 ppt of each other 78.9 percent of the time, and within ± 0.5 ppt 97.0 percent of the time. Only 8 of the 269 comparisons were outside the ± 0.5 ppt range and they all occurred during the lead-in period from lunar day -29 to lunar day 3. The largest plan-minus-base difference in sump source salinity was +0.8 ppt at lunar day -9. The overall base test average source salinity was 32.49 ppt and the plan test average was 32.50 ppt.

Salinity sampling

97. It was necessary during testing to monitor the distribution of salinity within the bay to ensure that general expected patterns were developing and that anomalies in the bay were explainable within the context of the test. In order to accomplish this task, a set of 19 stability monitoring stations throughout Chesapeake Bay and the major tributaries was selected to give a general picture of baywide salinity structure. These salinity monitoring stations were not a primary part of the comprehensive testing program but were selected mainly for comparison with other studies performed at the Chesapeake Bay model. The salinity monitoring stations were used to determine when the model had reached the dynamic salinity equilibrium required for test initiation and were a real-time test monitoring aid. Samples were taken at slack after flood at each of the 19 salinity monitoring stations on every tide 3 and every tide 30 throughout the tests. The samples were analyzed immediately and hand-plotted to facilitate rapid analysis. No abnormalities in density structure were observed in either test and, consequently, confidence in their comparability is high.

98. Salinities in the bay were sampled at individual stations at from one to five depths per station (Figures 22 and 23 and Table 14). Approximately

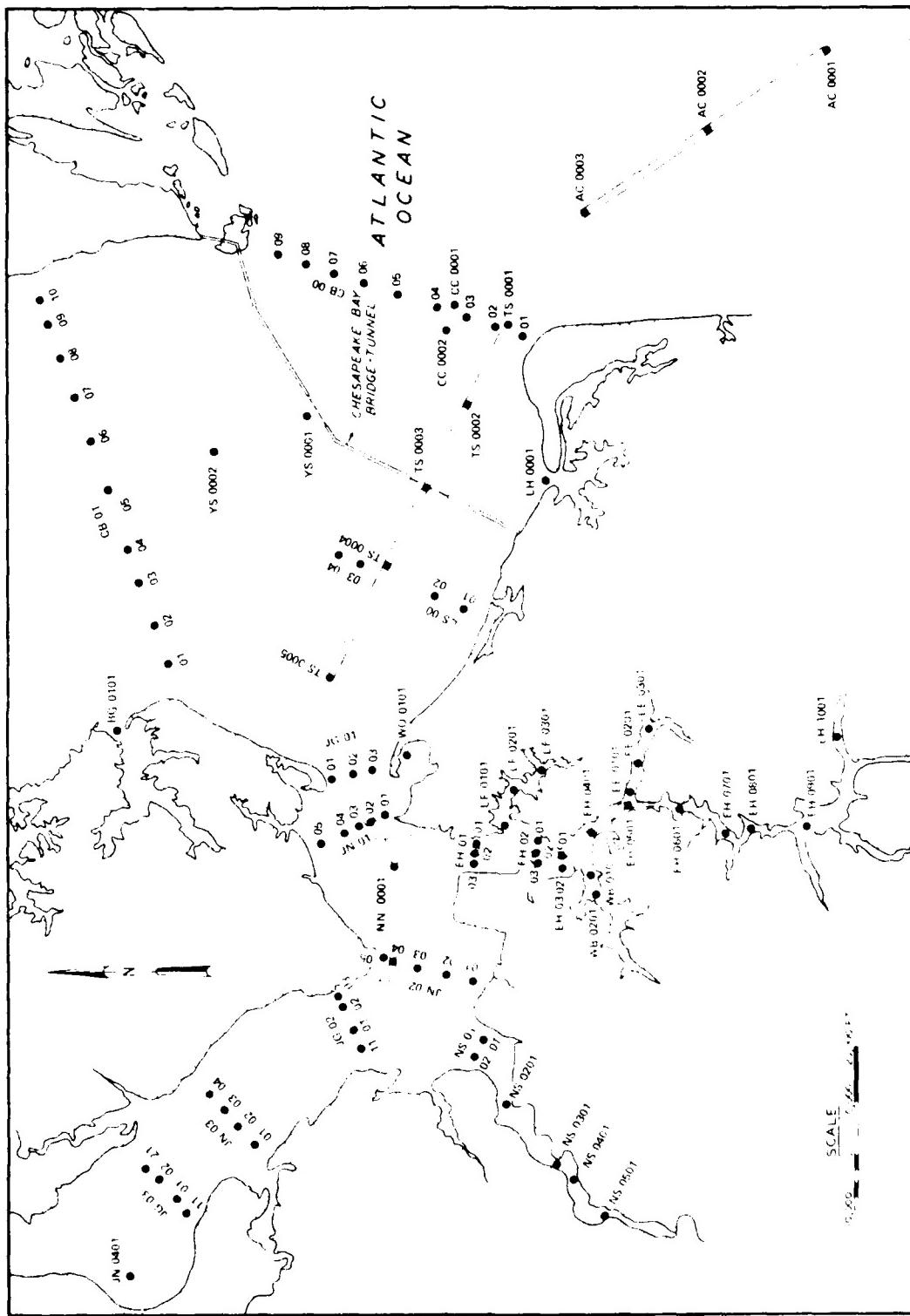


Figure 22. Salinity station locations within study area

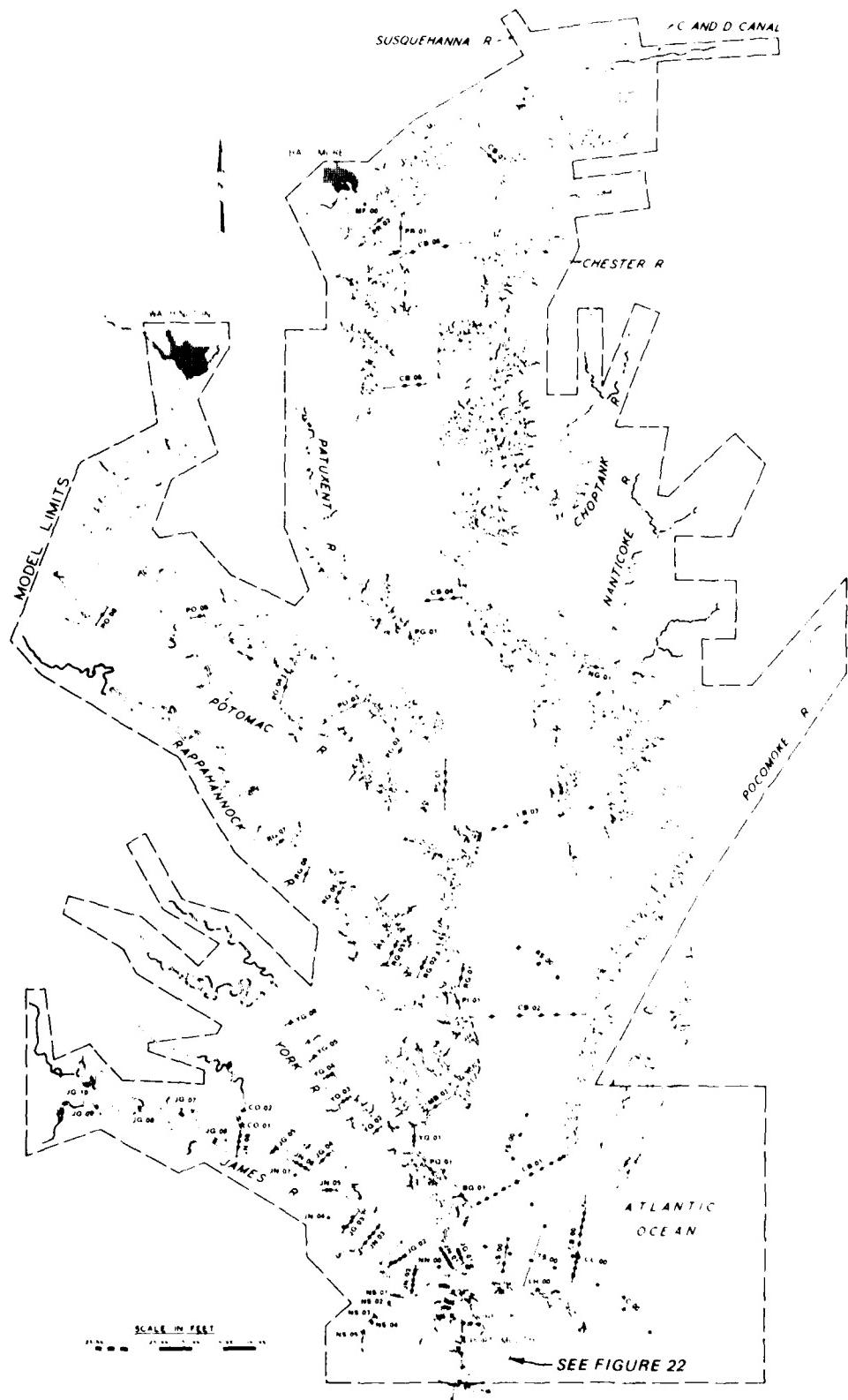


Figure 23. Map showing all of the salinity stations

500 samples were taken at each sampled tide. The sampled tides were 1, 10, 28, and 48 at slack after flood which represent high-spring, mean, low-spring, and neap tides, respectively (Figure 21). In all, 57,041 samples were collected in the plan test and 55,331 were collected in the base test. The number of additional samples for the plan test was due to additional sampling in the deepened channel.

Salinity Data Analysis

99. The purpose of the dynamic salinity tests was to determine what impact the deepened channels would have on the salinity distribution within the Chesapeake Bay system. Salinity sampling stations were positioned at 193 locations throughout the model so that the effects on the entire system could be determined. The majority of the stations were located near the project area in the lower bay and James River with care taken in the selection process so that biologically sensitive areas would be covered. Locations of the sensitive areas were provided by the Virginia Institute of Marine Science (VIMS) along with suggestions for nearby sampling locations. Where physically possible, these locations were used.

100. Performing a detailed data analysis on 193 stations and presenting the results in a technical report is an arduous and unnecessary exercise. Data from all 193 stations were inspected for base-to-plan salinity differences and a more reasonable number of stations were selected for a detailed analysis and presentation in this report. Data from 65 stations are presented in this report along with various graphical plots that were used in the data analysis. The stations chosen for inclusion in this report provide an adequate coverage of the entire bay with more stations selected from areas which showed notable base-to-plan salinity changes.

101. Salinity data were primarily analyzed by using several graphical techniques which are included in this report. First, the data were displayed from both tests in multiple time-histories beneath a total bay discharge freshwater hydrograph (Plates 151-215). The time-histories display the entire data set at 65 stations and are useful for observing changes in the vertical salinity structure resulting from hydrographic and tidal variations.

102. Contained in the same plates are displays of plan-minus-base differences at surface and bottom and plan-minus-base depth-averaged differences, both plotted against the same time scale. When a data point was missing from

one or both tests no difference was listed, thereby resulting in discontinuities in the plotted curves. At stations within the deepened channels, an additional depth was included in the plan test showing the deeper bottom. Bottom differences were calculated using the deepest depth at a station for each test.

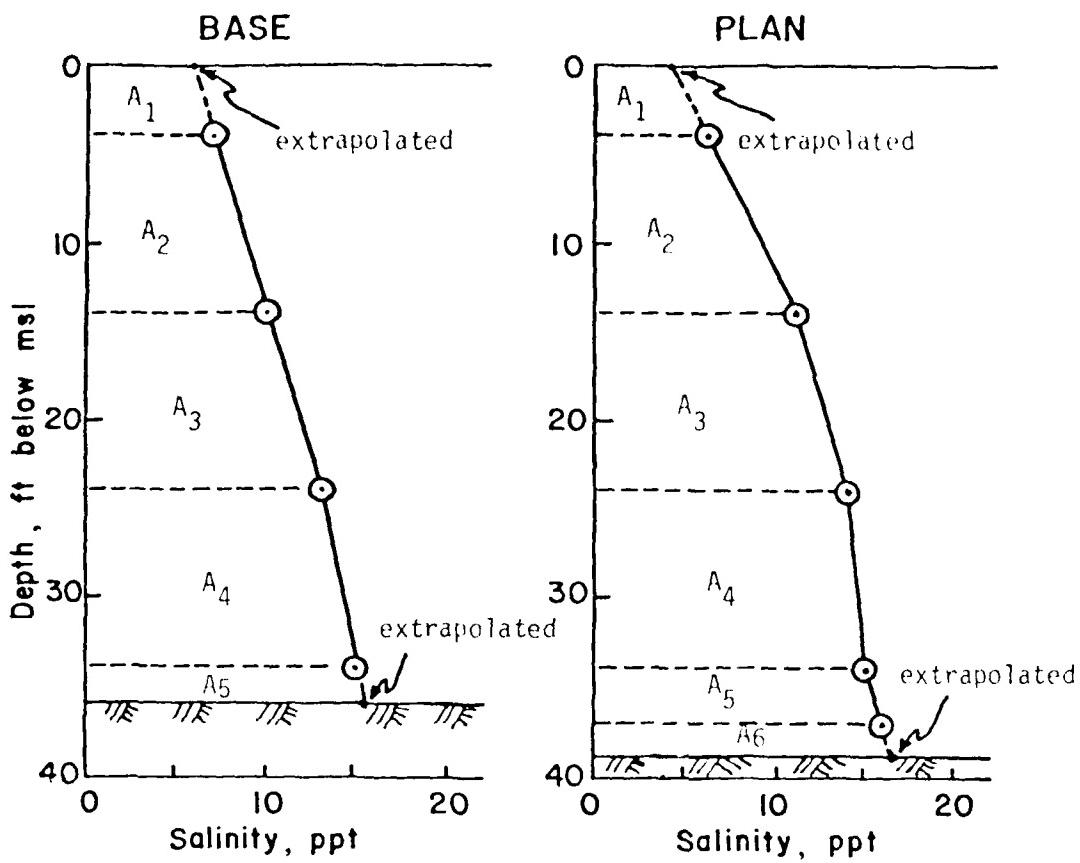
103. Salinity depth-averages were computed to determine the net salinity change integrated over the water column at various locations in the bay resulting from channel deepening. It should be firmly stated that one should not view depth-averaged differences as the single most important indicator of base-to-plan salinity differences. This method does not satisfactorily consider increased vertical stratification that often accompanies channel deepening. For a bottom dwelling organism, this is a crucial consideration. Base and plan depth-averages were computed as shown in Figure 24. There are some errors that are intrinsic to this method. Salinities at the surface and bottom boundaries are computed by extrapolation from the two adjacent depths. This is not accurate in any rigorous sense but it is a reasonable approximation that is applied in a similar fashion in both base and plan tests. When differences are computed, the effects of this error are minimized. In order to avoid the introduction of additional errors, the depth-averaging algorithm only considered those stations having a complete set of salinities for both base and plan tests at a given point in time. In other words, if a salinity value was missing from a certain depth at a given point in time, no depth-averaged salinity difference was computed. This accounts for the gaps in the depth-averaged difference plots (e.g., Plate 152).

104. The previously mentioned methods are adequate for observing base-to-plan differences at one station over time but do not allow a picture of salinity changes in a longitudinal or transverse sense. For this reason, longitudinal isohaline profiles were drawn using data sampled from the four tides of the neap-spring cycle during both high and low discharge periods.

Salinity Results

Model accuracy and repeatability

105. Prior to any discussion of the impacts of channel deepening on salinities in the bay, it is prudent to discuss the accuracy and repeatability of salinity data measured in the model. The term accuracy refers to closeness



$$\bar{SAL} = \frac{\sum_{i=1}^n A_i}{D}$$

$$\text{or } \bar{SAL} = \frac{\sum_{i=1}^n [1/2(SAL_i + SAL_{i+1})(d_{i+1} - d_i)]}{D}$$

where \bar{SAL} = depth-averaged salinity, ppt

SAL_i = salinity at depth i , ppt

d_i = depth i in feet below msl

D = total station depth, ft

Figure 24. Definition sketch: depth-averaged salinity

of salinity values measured in the model to the "true" values occurring in the prototype given that both model and prototype experience identical boundary conditions. The level of accuracy of the Chesapeake Bay model will never be exactly known because it is virtually impossible to reproduce in the model all the boundary conditions affecting the prototype (wind, rain, ship movement, Coriolis force, etc.). However, by considering the major forces affecting the hydrodynamics of the bay (variable tide, river inflows, and ocean source salinity), an approximation of the level of accuracy is possible.

106. The model has undergone two lengthy verification tests. The initial verification was accomplished in 1978 (Scheffner et al. 1981) and a re-verification in 1981 (Granat et al. in preparation) following extensive concrete repairs prior to the Norfolk Harbor study. Although direct comparability between individual model and prototype data points is not always possible due to different boundary conditions and other differences, these verification tests have shown that the model does a good job of reproducing the seasonal salinity variations resulting from a dynamic freshwater hydrograph and the neap-spring tide cycle. When used to determine base-to-plan salinity differences under similar boundary conditions, the model is accurate to within ± 1 ppt. Certainly not every measured data point will be accurate to within these limits, but the overall accuracy of the estimation of salinity changes resulting from channel deepening will be on that order. Further discussion of the individual inaccuracies that combine to form the ± 1 ppt accuracy level is lengthy and will not be addressed in this report.

107. A closely related and equally important aspect of model testing is the repeatability (or precision) of model results. Here repeatability refers to the closeness to one another of different sets of model salinity measurements taken under the same boundary conditions. Ideally, it would seem rational in both base and plan tests to bring the model to the same state of dynamic salinity equilibrium prior to initiation of testing using the same start-up procedure. In this manner, one can be assured that any base-to-plan salinity differences are the result of channel deepening and not due to some inconsistency in the model start-up procedure. However, there is an interesting dilemma springing from this approach. Will the model, having different base and plan geometric configurations with the deepened channels, be able to reach the same salinity stability under boundary conditions that are in every other way equivalent? A close inspection of base-versus-plan lead-in

salinities and a good deal of model experience are required in order to satisfactorily answer that question.

108. This dilemma is of particular importance to the Norfolk salinity tests. Both the base and plan tests were brought to stability in a similar fashion by initially flooding the model with fresh water and then introducing saline water from the ocean source via a variable tide generated at the ocean. Despite the desired strictness of control in the start-up of both base and plan tests, variations in the rates of fresh- and saltwater introduction were noticed between tests which resulted in different salinity distributions at equivalent points in time. Due to differences in the model start-up procedures and perhaps to a much lesser extent the different model geometries, the model did not reach salinity stability in the same period of time for the plan test as in the base condition. From past experiences with the model, it was decided that an additional day (200 tide cycles) of lead-in time was needed in the plan condition to obtain a state of stability similar to the base condition. After the additional day of lead-in, the overall plan salinities were approximately 0.5 ppt higher than the base salinities. The primary study area in the lower bay and James River areas had very similar base and plan salinities at this time, while areas showing the maximum lead-in differences were distant from the study area in the middle and upper bay. By the end of testing, the overall base-to-plan salinity difference at the stability monitoring stations was near 0.0 ppt. The net effect of differing salinity beginning conditions caused by dissimilar base-to-plan start-up procedures would be to slightly overestimate the magnitude of any increased salinities in the plan test. The areas showing the greatest base-to-plan lead-in differences will be discussed in more detail later in this report.

Neap-spring salinity variations

109. One of the purposes of this model study was to determine what differences in salinity structure could be associated with the proposed channel deepening project. Findings from the study would ultimately be used to determine if the project has any adverse effects on the environment, and if so, perhaps the benefits of the project would be reassessed. Channel deepening often alters the salinity structure of estuaries. In most cases, the net effect would be to increase salinity intrusion on the bottom with increased vertical salinity stratification. Net increases in salt averaged over the water column are sometimes evident as well. It becomes the task of local authorities to

ultimately determine whether or not the noted changes could adversely affect the estuary, most particularly the biota. This test was designed to determine over time the nature and magnitude of salinity variations caused by the channel deepening so that these values could be provided to local authorities for their planning purposes. However, before any degree of concern is placed on salinity differences reported herein, an understanding of the prototype through its physical model representation is needed especially if there are naturally occurring salinity variations which make the magnitude of base-to-plan differences comparatively small.

110. The lower Chesapeake Bay along with the James, York, and Rappahannock Rivers experience tidally induced salinity variations that have been noticed in the prototype (Haas 1979) and confirmed in the Chesapeake Bay model. The neap-spring variations, as they are called, occur when lower amplitude tides (tides 28 and 48) allow stratification in the water column followed by larger range tides (tides 1 and 10) which mix the column again. Intertidal salinity changes of as much as 5 to 8 ppt are common at a single depth along with depth-averaged salt variations of 3 to 5 ppt (Figures 25-27). Extreme variations, such as at sta JG2302 (Figure 25), can result in variations of depth-averaged and bottom salinity changes of 9 ppt and 14 ppt, respectively. Neap-spring changes in the project area appear to be greatest during periods of high discharge when the vertical density gradient is the strongest. A definition sketch showing the relationship between the neap-spring tide cycle and salinity variations is given in Figure 28 (from Richards and Gulbrandsen 1982).

111. The time-histories in Plates 151-215 illustrate that this phenomenon is present throughout the model to various degrees with the strongest variations located in the vicinity of the project area. From each reach of the deepened channels, a representative station was chosen and displayed in Figures 25-27. Sta AC0002 is located in the Atlantic Ocean Channel, TS0004 in the Thimble Shoal Channel, JN0103 in the Norfolk Harbor Channel, and EH0601 upstream in the Elizabeth River. Sta JG2302 in the James River was chosen because it is the most extreme example of variations, and sta CB0404 in the middle bay shows very little if any neap-spring variation.

112. The mechanism responsible for causing neap-spring variations is not suitably described in the literature nor is it sufficiently understood. From the observations of data from various model tests including the Norfolk Harbor study, it appears to occur in areas that contain large vertical density

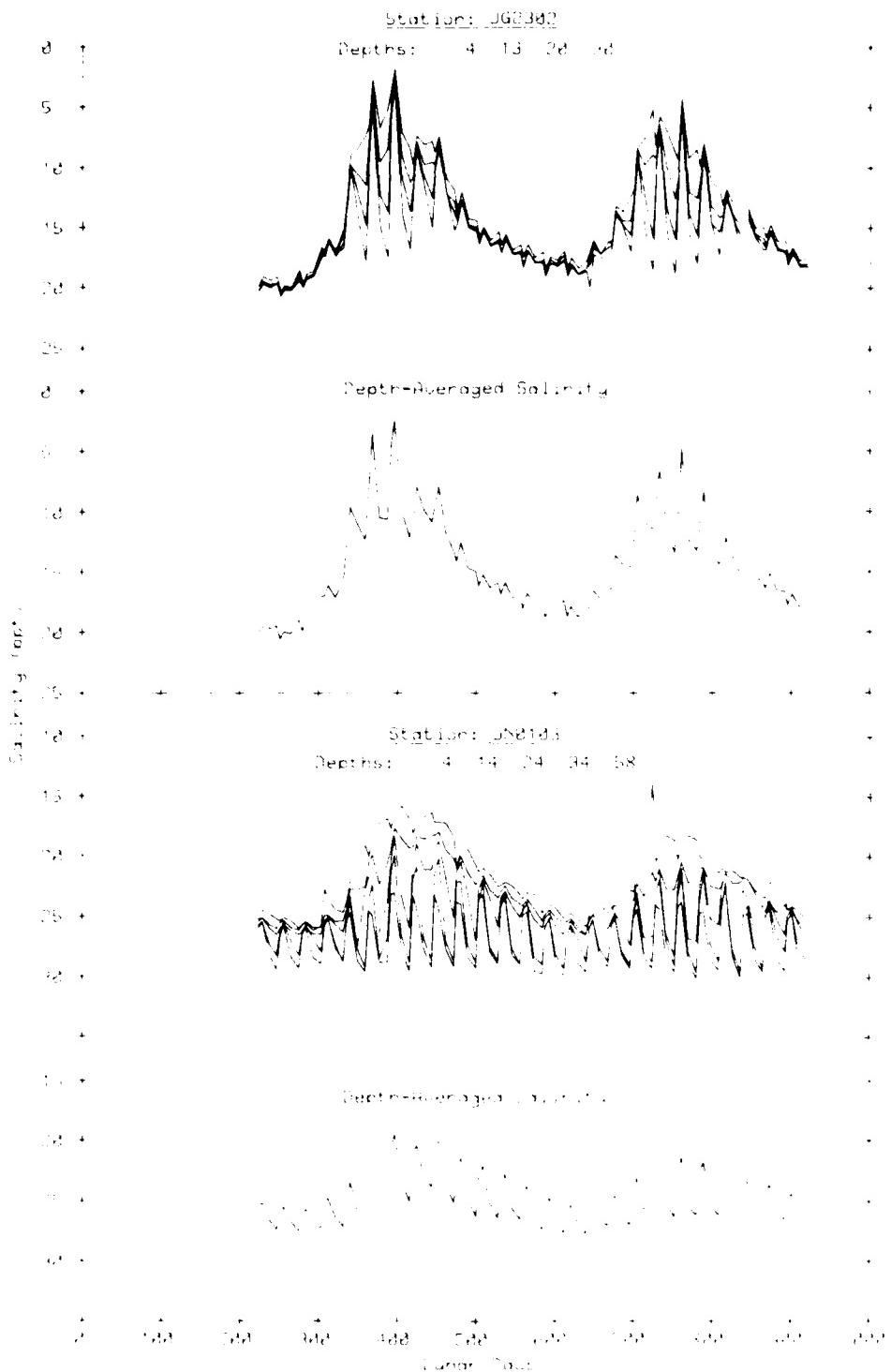


Figure 25. Typical neap-spring and seasonal salinity variations in the Lower James River.

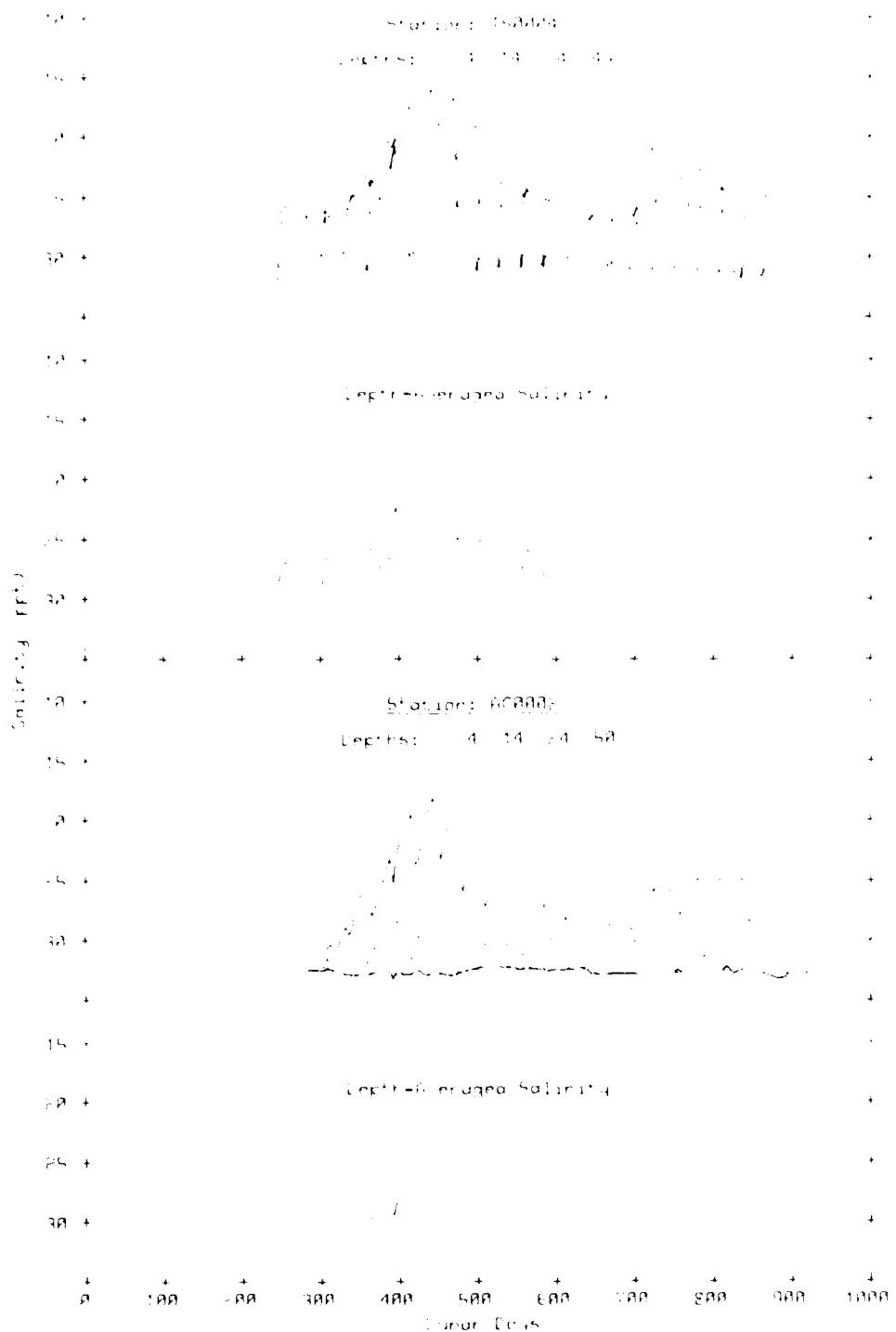


Figure 26. Typical neap-spring and seasonal salinity variations in the lower Chesapeake Bay and Atlantic Ocean

Figure 27. Typical neap-spring and seasonal salinity variations in the Elizabeth River and mid-bay regions

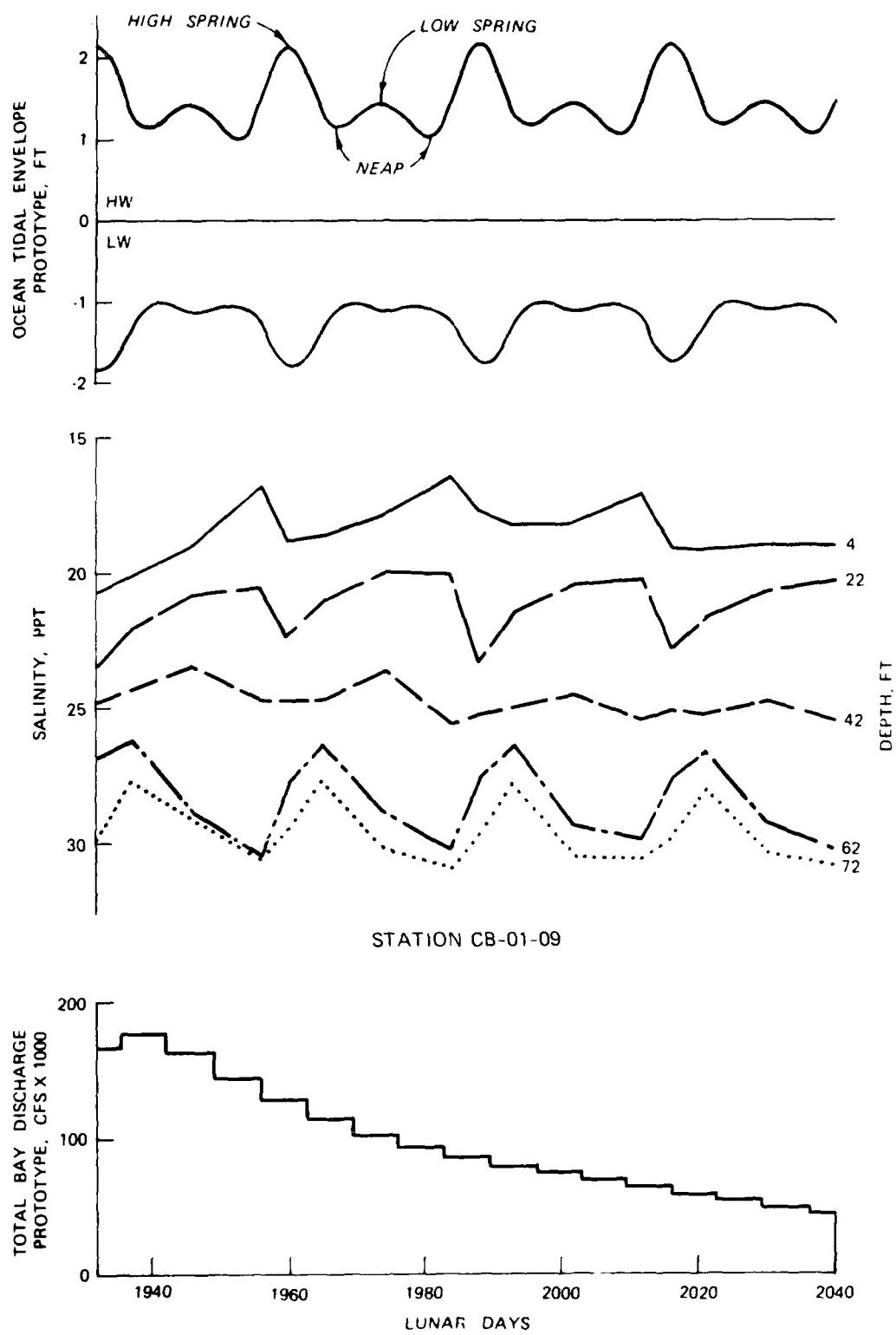


Figure 28. Definition sketch showing salinity response to neap-spring tidal variations

gradients which, of course, are noticed in the lower bay and Virginia rivers. This thesis seems to be supported by the observations that when neap-spring variations occur at a station throughout a time-history, they are greatest during high discharge conditions when the water column is most stratified (Figure 24).

113. The major emphasis in this discussion is that organisms which live in the project area should be adapted to survive neap-spring changes in salinity without significant stress to their populations. Neap-spring salinity changes have existed for ages and will continue to do so unless massive geometric changes and/or flow suppression schemes are implemented by man or nature. Nevertheless, the plan condition in this test was analyzed for structural changes in this neap-spring tide cycle.

Discharge-induced salinity variations

114. Variations in the supply of fresh water to the estuary are also a source of naturally occurring salinity variations. Periods of high discharge during the winter and spring seasons generally freshen the entire water column with an increased vertical salinity stratification. With the approach of the summer and early autumn low-flow periods, the salinity in the entire water column gradually increases and the overall stratification decreases. Longitudinal salinity structure changes induced by freshwater flow variations are very large at times, especially in the higher discharge rivers of the bay. Smaller discharge rivers also experience structural changes related to the hydrograph but to a lesser extent due in part to the fact that tidal flows in and out of the river are large in comparison with freshwater discharge.

115. The James River shows the largest seasonal variations in salinity in the study area. It is one of the higher discharge rivers on the bay (Plate 149), and the range of flow magnitudes between high and low conditions is great. The flushing effect of a high discharge rate can be observed in the James River longitudinal isohaline profiles (Plates 216 and 217). In general over all tidal conditions, the 1-ppt isohaline is located approximately 125,000 ft (23.5 miles) farther downstream during the high-flow period than during the low-flow period. Similarly, the 15-ppt isohaline is about 50,000 ft (9 miles) farther downstream during the high-flow conditions.

116. The Elizabeth River can be classified as a low discharge river (Plate 150). Flows in and out of the river are largely tidal in nature and as a result the Elizabeth is a rather well-mixed estuary with the 20-ppt isohaline

extending upstream to sta EH1001 during the low-flow period (Plate 218). The Elizabeth River does not exhibit the well-defined "wedge" of salinity that was observed moving upstream and downstream in the James River with changes in freshwater flow magnitude. However, the estuary clearly becomes much more stratified during the high-flow period (Plate 219). The 20-ppt isohaline in the vicinity of sta EH1001 is replaced by a 6- or 8-ppt isohaline. During the high-flow period, the surface salinities along the estuary are 8 ppt or more fresher than during the low-flow period, but bottom salinities are only about 1 ppt fresher.

117. The Atlantic Ocean and Thimble Shoal Channels are located in open areas of the bay and ocean and do not have a single, most predominant source of fresh water. They do, however, experience similar longitudinal reactions to the variable hydrograph (Plates 220 and 221) observed in the James and Elizabeth Rivers. In the upper water column near sta TS0005, the 17- to 20-ppt isohaline which is present during high-flow conditions is replaced by a 25- to 26-ppt isohaline in the low-flow period. At the bottom, the 31-ppt isohaline remains in essentially the same position during both high- and low-flow periods at tides 1 and 10. However, at tides 28 and 48 the 31-ppt isohaline intrudes about 50,000 ft farther upstream in the Thimble Shoal Channel during low-flow periods. The strength of neap-spring variations in this region is dominant as was shown in Figure 26.

Base-to-plan salinity differences

118. With an understanding of the dynamic nature of the lower bay under undeepened existing conditions, we can now address changes in salinity structure which may be expected with the proposed channel deepening. Changes that occurred in the deepened plan condition were examined in four ways: (a) plan-minus-base differences at each depth (most importantly the bottom depth), (b) plan-minus-base differences in depth-averages, (c) channel versus shallow-water redistributions of salinity, and (d) plan versus base changes to the neap-spring salinity response. Each of these will be discussed separately. It should again be stated in this discussion of differences that no significant changes due to channel deepening were noticed in the model north of range CB01. Any changes that are displayed in the plates are the result of boundary and initial condition problems in model control and not channel deepening.

119. Plan-minus-base differences at each depth were plotted through

time in Plates 151-215. It would be convenient to generalize on the nature of salinity differences, but it is difficult because each individual station lies in a portion of the estuary where freshwater and tidal flows have different relative strengths as well as different local geometries. Each station should be inspected individually for differences at depth with the realization that there is noise in the data set so no particular significance should be assigned to any one point. Also it should be realized that the degree of model density stability increases with time so data collected in the later portions of the test are more realistic in predicting differences. It is safe to generalize that channel stations showed increased bottom salinities with an overall increase in vertical salinity stratification. Shallow-water areas and channels that were not deepened showed less structural variations and less increased salinity than deepened-channel stations. Figures summarizing those findings will be presented later.

120. Depth-averages were computed to predict what net imports or exports of salt could be expected in the project area. Results from 65 study stations were grouped into five categories describing the average net increase or decrease in depth-averages throughout the test. The following summarizes the observed changes.

Net Increase, ppt				Net Decrease	
		0.51 to 0.00 to 0.50	1.01 to 1.00	1.51 to 1.50	2.00 0.00 to 0.50
AC0002	JG0601	PG0101	EE0101	EH0202	EH0102
CB0109	JN0104	P00202	EH0401	EH0501	CB0008
CB0208	JN0201	RG0102	EH0901	EH0601	JN0101
CB0303	JN0202	RG0202	EH1001	EH0701	JN0103
CB0404	JN0203	RG0501	JG0203	EH0801	JN0105
CB0505	JN0502	TS0002	JG0302		JN0205
CB0611	JN0603	WB0201	JN0102		LF0101
CB0705	JN0801	W00101	JN0204		LS0001
CG0101	MF0001	YG0102	JN0303		LS0002
EH0301	NS0101	YG0302	NN0001		LS0003
JG0103	NS0201	YG0501	TS0004		LS0004
JG0402	NS0301				
JG0502	NS0401				

121. As shown in the preceding list, stations upstream of range CB01 as well as the upper James River show little if any changes in their depth-averaged salinity. Channel stations in the Elizabeth and lower James Rivers along with the upper end of Thimble Shoal Channel show noticeable average net salinity increases from 0.5 to 1.7 ppt. Some stations, primarily in

shallow-water areas, actually showed depth-averaged freshening in the plan test although very slight, always less than 0.5 ppt lesser.

122. The freshening of shallow-water areas in the Horseshoe Shoal area is an example of a transverse redistribution of salt in the cross section due to channel deepening. Freshening rarely occurred at any of the stations unless they were adjacent to a deepened channel area. Figure 29 shows depth-averaged differences across the Horseshoe Shoal transect (LS0001-LS0004) with sta TS0004 (Figure 22) being the deepened station. The 1-ppt approximate increase in depth-averaged salinity at sta TS0004 and the slight freshening at sta LS0001, LS0002, LS0003, and LS0004 illustrate this point. During the first high-flow season, the redistribution is particularly strong. Other transects show a similar response to varying degrees in both the bottom differences and depth-averaged differences plots.

123. Bottom differences were one of the most important results of the study. It is on the bottom where certain biota, particularly shellfish, are particularly susceptible to adverse salinity changes. Maps summarizing bottom differences for the various tide and hydrograph conditions are given in Plates 222-236. These plates show that channel deepening increases salinity along the bottom of the channels by up to 4.0 ppt, but shallow-water areas and undeepened channels show very little change. In fact, outside of the Elizabeth and lower James channel areas, increases were rarely as great as 1 ppt for any tide or hydrograph condition tested.

124. The bottom differences discussed thus far are viewed at discrete points in time during particular tidal or hydrographic conditions. It is also important to view the change in the bottom variations through time to detect any possible change to the neap-spring salinity response. Changes to the neap-spring response are most important on the bottom for previously stated reasons. They are also easily observable on the bottom.

125. An inspection of the base and plan time-histories in Plates 151-215 will reveal the magnitude of the cyclic neap-spring response on the bottom depths. For example, in Plate 163, sta EH0102 shows a different neap-spring response between base and plan conditions. The base contains an approximate 3- to 4-ppt variation throughout the hydrograph while the plan shows only a 2- to 3-ppt range. This damping of the tidally induced neap-spring response on the bottom is prevalent in the deepened channel areas of the Elizabeth River. From sta EH0102 upstream to EH0801, the damping is fairly consistent with base

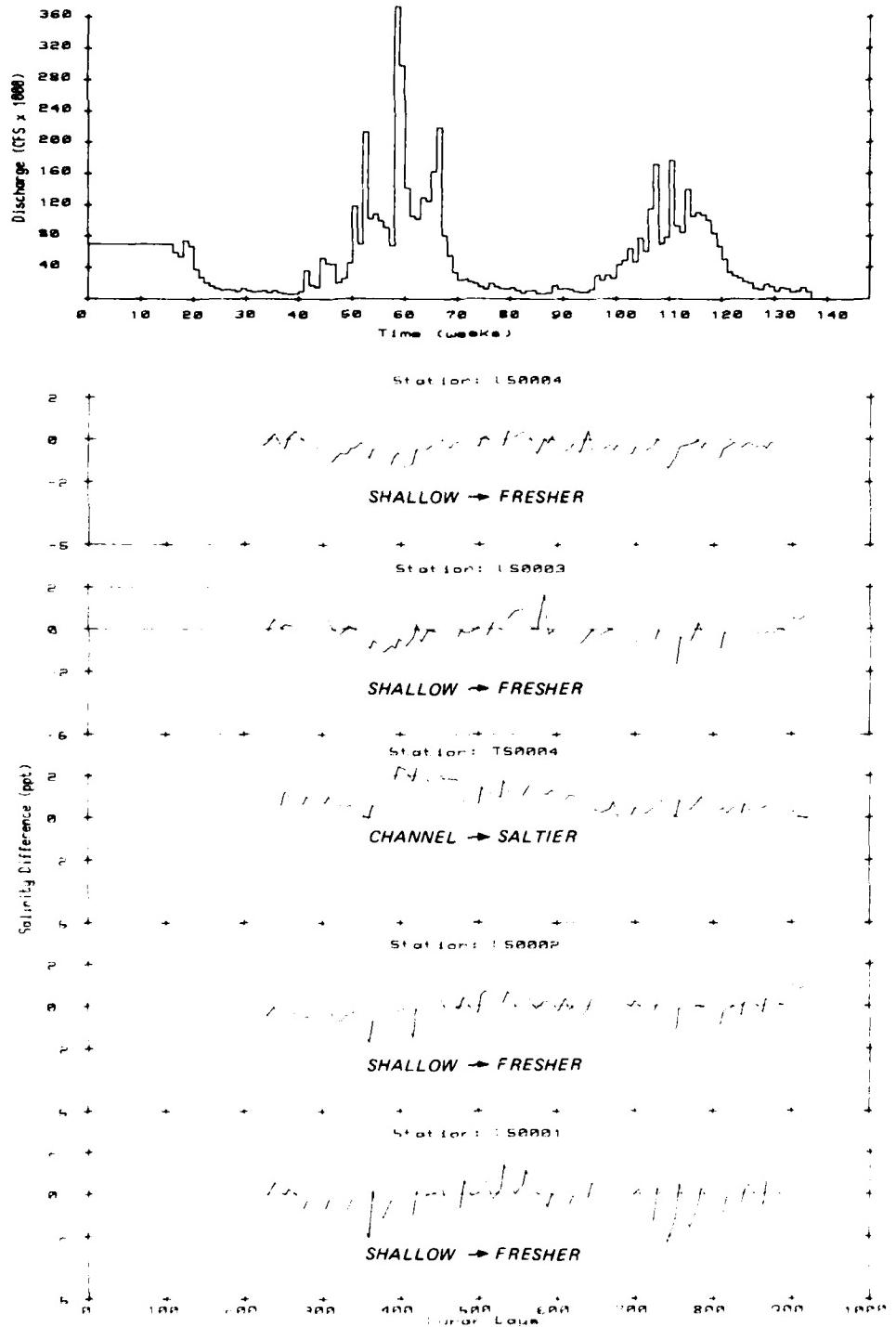


Figure 29. Depth-averaged salinity redistribution across the Horseshoe Shoal transect

ranges varying between 2 and 3 ppt and the plan between 1 and 2 ppt. On the average, a 1-ppt damping was noticed with the exception of sta EH0301 which showed an increased bottom range. This station, however, exists in a portion of the river which was not deepened. Both base and plan tests had their salinity probes located at the same depths. The observation of increased bottom range in the plan condition at sta EH0301 is consistent with the 48-ft depth downstream at sta EH0202 and the 44-ft depth upstream at sta EH0401. Both experienced slight range increases in what were the base bottom depths.

126. Since three channel sections were dredged in the lower bay and James River area it is interesting that only the deepened portions of the Elizabeth River showed any distinguishable changes in the neap-spring salinity response. A possible explanation for this observation stems from the fact that each of the channel sections, Thimble Shoal, lower James River, and the Elizabeth River, lie in radically different portions of the estuary. The James River is a high discharge river with broad transverse dimensions compared with its relatively narrow navigation channel widths. The Thimble Shoal Channel lies in the lower bay where the significant freshwater influences of the James and other rivers are felt plus again it has a narrow navigation channel in a broad cross section. Both are highly dynamic zones of turbulent mixing with strong freshwater and tidal mixing inputs and strong current velocities. The Elizabeth River, by contrast, is a narrow river with negligible freshwater input, weak current velocities, and its deepening represents a larger portion of its total conveyance area. Relatively little mixing is present with successive neap and spring tide cycles having little influence on the bottom current velocities and thereby these salinities.

127. The biological ramifications of a damped neap-spring response are worthy of consideration. A variety of organisms can tolerate increases or decreases in salt concentration provided they are of limited duration. The damped neap-spring response along with the slight increase of bottom salinities could place a number of species in a stressful position. Biologists would have to determine the tolerance levels for each species versus the changes predicted in this report. Normally, shellfish are of the most concern in deepening studies both because of their bands of salinity tolerance and those of their predators. One heartening fact observed in viewing the data is that where changes do occur either by absolute or in a time-varying neap-spring fashion, they inevitably occur in nonactive biological areas in the

deep channels. Shallow-water areas where most shellfish thrive were relatively unaffected by this deepening project especially when compared with the magnitude of natural salinity variations which already occur in the base condition.

PART V: CONCLUSIONS

128. Changes in tidal elevations, amplitudes, and phasing which may be due to the effects of channel deepening were sufficiently small that they were undetectable with the measurement techniques used at the hydraulic model. Model measurement techniques are of sufficient accuracy that significant changes would have been noticed; therefore none are expected.

129. Several subtle velocity variations in the model tests were apparently due to channel deepening. An overall decrease in velocity amplitude of about 0.13 fps was noticed during the plan test. This is consistent with the principles of continuity, but the magnitude of change is close to the accuracy limitations of model instrumentation. Slight increases in flood predominance were noticed under average inflow conditions indicating perhaps that salinity intrusion may move upstream in the study area. This observation is consistent with the observed increased salinities. Overall changes in model velocities could be attributed to the effects of channel deepening but the magnitude of the changes is barely detectable.

130. Variations in the model salinity distribution were noticed that could be attributed to channel deepening. The greatest differences were noticed in the deepened channel areas where increases in the bottom salinities varied between 0 and 4.0 ppt. Channel depth-averaged increases varied between 0 and 2 ppt. Shallow-water areas near the deepened channels experienced much less of a salinity increase. At times there was actually a slight freshening of the shallow waters. Stations elsewhere in the model showed modest increases in depth-averaged salinity but were normally less than 0.5 ppt.

131. The salinity tests documented the locations of stations in the study area that exhibit large (commonly as great as 5 to 8 ppt) salinity changes due to the neap-spring tide cycle. The entire study area experienced these variations that are naturally occurring and not caused by channel deepening. Channel deepening did, however, cause a slight change in the neap-spring salinity response. It was characterized by a damping of the cyclical salinity variations in the bottom depths of the Elizabeth River. Elsewhere, little if any neap-spring changes were detectable.

132. The intention of this report and its accompanying data set is to furnish biologists and planners with the information necessary to assess the impacts of the proposed deepening project on the environment. Almost all

deepening projects cause some degree of environmental change and this project is no exception. Every effort has been made to quantify the extreme natural salinity variability in the project area resulting from hydrographic and tidal variations. Before any value judgments are made pertaining to the benefits of the dredging versus any possible environmental concerns, a good knowledge of the region's natural variability should be obtained. The variations in salinity response caused by channel deepening are small compared with the variations that occur naturally in the region.

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Table 1
Sewage Treatment Plans (STP) and Other Diversions

<u>I.D.</u>	<u>Name</u>	<u>Tributary</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Discharge cfs</u>
A	James River STP	James River	37°04'35"	76°32'20"	26
B	Boat Harbor STP	James River	36°37'30"	76°24'48"	34
C	Army Base STP	Elizabeth River	36°55'20"	76°20'10"	23
D	Lamberts Point Outfall	Elizabeth River	36°52'58"	76°24'00"	50
E	Chesapeake - Elizabeth STP	Little Creek	36°56'35"	76°10'17"	40
-	Surry Nuclear Cooling Intake	James River	37°09'33"	76°40'15"	3740*
-	Surry Nuclear Cooling Outfall	James River	37°10'09"	76°42'11"	3740*
TOTAL					173*

*The discharge of 3740 cfs for the Surry Nuclear Power Plant cooling diversion was not added to the model, but was instead circulated from the downstream side of Hog Island to the upstream side to simulate prototype conditions. Hence, the 3740 cfs is not included in the total.

Table 2
Freshwater Discharges
Steady-State Velocity and Tide Tests

Inflow Number	Tributary	Discharge, cfs	
		Tests 1 & 2	Tests 3 & 4
1	Nansemond River	1,063	372
2	Chickahominy River	826	289
3	Appamattox River	2,763	967
4	James River	20,711	7,249
5	York River	7,597	2,659
6	Rappahannock River	8,120	2,842
7	Wicomico River (Potomac)	1,177	412
8	Occoquan Creek	6,771	2,370
9	Anacostia River	1,663	582
10	Potomac River	21,997	7,699
11	Patuxent River	2,517	881
12	Severn River	660	231
13	Patapsco River	1,751	613
14	Gunpowder River	2,291	802
15 & 22	Susquehanna River	106,335	37,217
16	Bohemia River	1,103	386
17	Chester River	1,434	502
18	Wye River	543	190
19	Choptank River	2,334	817
20	Nanticoke River	4,626	1,619
21	Pocomoke River	2,849	907
23	Elizabeth River	869	304
Total Bay Discharge		200,000	70,000

Table 3

Tide Station Locations
Steady-State Tide Tests

<u>Station</u>	<u>Body of Water</u>	<u>Latitude</u>	<u>Longitude</u>
OCEAN	Atlantic Ocean	36°58'54"	75°33'27"
Sta 3	James River (Old Pt. Comfort)	37°00'18"	76°18'50"
CB0001	Chesapeake Bay	36°56'17"	76°00'23"
CB0004	Chesapeake Bay	37°00'14"	75°59'30"
CBCJ08	Chesapeake Bay	37°03'13"	75°58'37"
CB0101	Chesapeake Bay	37°06'00"	76°14'36"
CB0105	Chesapeake Bay	37°08'51"	76°08'48"
CB0109	Chesapeake Bay	37°11'42"	76°02'07"
JG0302	James River	37°03'21"	76°35'35"
JN0202	James River	36°55'42"	76°25'44"
EH0203	Elizabeth River	36°53'09"	76°20'13"
EH0901	Elizabeth River	36°45'05"	76°17'46"
EE0301	East Branch Elizabeth River	36°50'13"	76°14'40"
WB0201	West Branch Elizabeth River	36°51'18"	76°21'15"
TS0003	Thimble Shoal Channel	36°58'24"	76°06'30"
TS0005	Thimble Shoal Channel	37°00'18"	76°13'54"
YS0001	York Spit Channel	37°02'43"	76°04'23"

Table 4A

TEST 1

Steady-State Tides: 200,000 cfs; +2.4 ft cosine tide

STATION	BASE				PLAN				PLAN - BASE			
	PHASE	AMP	A(0)	R ₀₀₂	PHASE	AMP	A(0)	R ₀₀₂	PHASE	AMP	A(0)	B/P: R
OCEAN	206	2.70	-0.04	0.990	213	2.32	-0.11	0.994	?	0.02	-0.06	0.992
STA. 3	249	1.78	0.18	0.992	254	1.74	0.04	0.995	5	-0.03	-0.14	0.996
C80001	217	2.24	-0.07	0.989	226	2.23	-0.02	0.991	9	-0.01	0.05	0.988
C80004	217	2.13	0.03	0.983	227	2.16	-0.10	0.987	10	0.02	-0.22	0.987
C92008	218	2.03	0.21	0.986	229	2.05	-0.17	0.990	11	0.02	-0.37	0.983
C80101	239	1.59	0.21	0.986	247	1.65	0.05	0.991	8	0.06	-0.16	0.992
C80105	239	1.55	0.23	0.989	247	1.56	0.02	0.990	8	0.01	-0.20	0.991
C80109	244	1.48	0.32	0.981	249	1.46	-0.01	0.994	5	0.05	-0.33	0.997
JG0302	294	1.58	0.37	0.980	301	1.48	0.44	0.981	7	-0.02	0.08	0.993
JN0202	262	1.87	0.13	0.991	268	1.86	0.00	0.990	6	-0.00	-0.05	0.993
EH0203	257	1.93	0.41	0.993	262	1.96	0.11	0.988	5	0.03	-0.38	0.996
EH0501	259	2.12	0.03	~.962	266	2.12	0.01	0.967	7	-0.00	-0.02	0.993
EE0301	260	2.03	0.23	0.980	265	2.02	0.10	0.981	5	-0.00	-0.13	0.996
LB0201	262	1.97	0.18	0.990	267	2.00	0.03	0.980	5	0.03	-0.15	0.997
TS0003	224	1.99	0.02	0.971	234	2.01	0.03	0.989	10	0.02	0.01	0.985
TS0005	235	1.05	0.11	0.995	243	1.89	-0.09	0.994	8	0.04	-0.20	0.991
YS0001	228	1.79	0.06	0.997	235	1.85	-0.13	0.997	7	0.06	-0.19	0.992

(Continued)

Table 4B
TEST 2

Steady-State Tides: 200,000 cfs, ± 1.5 ft cosine tides

STATION	BASE				PLAN				PLAN - BASE			
	PHASE	AMP	A(0)	R**2	PHASE	AMP	A(0)	R**2	PHASE	AMP	A(0)	B/P: R
OCEAN	285	1.46	-0.05	0.994	195	1.40	-0.02	0.987	-10	-0.06	0.03	0.983
STA. 3	247	1.11	0.19	0.993	236	1.13	0.03	0.990	-11	0.02	-0.16	0.981
CB0001	220	1.40	-0.04	0.989	206	1.39	0.15	0.989	-14	-0.00	0.18	0.970
CB0004	219	1.37	-0.00	0.987	209	1.33	-0.09	0.974	-10	-0.04	-0.08	0.986
CB0008	224	1.32	0.06	0.988	210	1.32	-0.08	0.985	-14	-0.01	-0.14	0.969
CB0101	240	1.11	0.10	0.990	230	1.11	-0.03	0.979	-10	-0.00	-0.13	0.983
CB0105	246	1.00	0.06	0.978	229	0.99	-0.13	0.988	-17	-0.02	-0.19	0.961
CB0109	245	1.00	0.09	0.991	233	0.94	0.05	0.982	-12	-0.06	-0.04	0.979
JG0302	294	1.02	0.26	0.983	281	1.01	0.19	0.986	-13	-0.02	-0.07	0.973
JH0202	259	1.16	0.11	0.986	245	1.17	0.06	0.985	-14	0.01	-0.06	0.975
EH0203	255	1.25	0.20	0.992	241	1.28	0.14	0.987	-14	0.02	-0.06	0.975
EH0901	260	1.36	0.16	0.981	247	1.32	0.05	0.982	-13	-0.03	-0.11	0.974
EE0301	257	1.32	0.22	0.979	248	1.31	0.11	0.983	-9	-0.01	-0.11	0.989
LB0201	258	1.31	0.30	0.988	247	1.30	0.05	0.992	-11	-0.00	-0.25	0.980
TS0003	227	1.28	-0.07	0.985	216	1.23	0.08	0.979	-11	-0.04	0.15	0.981
TS2005	***	***	***	***	223	1.23	-0.03	0.987	***	***	***	***
YS0301	228	1.19	0.08	0.981	218	1.17	0.08	0.984	-10	-0.02	-0.07	0.984

(Continued)

(Sheet 2 of 4)

Table 4C
TEST 3

Steady-State Tides: 70,000 cfs, +2.4 ft cosine tide

STATION	BASE				PLAN				BASE - PLAN			
	PHASE	AMP	A(θ)	R**2	PHASE	AMP	A(θ)	R**2	PHASE	AMP	A(θ)	B/P: R
OCEAN	193	2.31	-0.11	0.990	189	2.27	-0.08	0.991	-4	-0.04	0.04	0.998
STA. 3	233	1.84	0.05	0.990	229	1.83	-0.06	0.990	-4	-0.01	-0.11	0.998
CB2001	283	2.23	-0.12	0.984	202	2.28	-0.23	0.975	-1	0.05	-0.12	1.000
CB2224	211	2.11	-0.16	0.989	205	2.15	-0.06	0.991	-6	0.03	0.10	0.993
CB2028	289	2.10	-0.02	0.991	201	2.02	-0.17	0.988	-8	-0.08	-0.15	0.990
CB2101	224	1.67	0.18	0.988	222	1.68	-0.09	0.982	-2	0.00	-0.28	0.999
CB2105	224	1.51	0.04	0.994	215	1.52	-0.07	0.992	-9	0.00	-0.11	0.987
CB2109	228	1.45	-0.05	0.990	221	1.44	-0.26	0.988	-7	-0.02	-0.21	0.991
JCB302	280	1.53	0.26	0.969	277	1.54	-0.00	0.942	-3	0.01	-0.26	0.999
JN0282	245	1.87	0.88	0.992	239	1.87	0.09	0.990	-6	-0.00	0.00	0.995
EH0203	244	1.99	0.21	0.989	241	2.02	0.15	0.991	-3	0.02	-0.07	0.999
EH2901	246	2.19	0.18	0.958	242	2.14	0.00	0.960	-4	-0.05	-0.18	0.997
EE0301	249	2.13	-0.08	0.981	237	2.09	-0.07	0.981	-3	-0.04	0.01	0.999
LB2281	246	2.05	0.28	0.989	245	2.03	-0.02	0.992	-1	-0.01	-0.30	1.000
TS0003	213	2.06	0.00	0.994	210	2.00	-0.13	0.990	-3	-0.06	-0.13	0.999
TS2005	***	***	***	***	221	1.84	0.01	0.987	**	****	****	****
YS0001	212	1.80	-0.11	0.970	207	1.74	-0.19	0.992	-5	-0.06	-0.09	0.996

(Continued)

(Sheet 3 of 4)

Table 4D

TEST 4

Steady-State Tides: 70,000 cfs, +1.5 ft cosine tide

STATION	BASE				PLAN				PLAN - BASE			
	PHASE	AMP	A(θ)	R**2	PHASE	AMP	A(θ)	R**2	PHASE	AMP	A(θ)	B/P: R
OCEAN	197	1.46	-0.04	0.994	187	1.46	-0.06	0.986	-10	-0.01	-0.02	0.986
STA. 3	241	1.20	0.15	0.990	226	1.17	-0.02	0.984	-15	-0.03	-0.17	0.968
C62001	208	1.39	0.10	0.991	201	1.42	-0.03	0.993	-7	0.03	-0.14	0.991
C63004	205	1.38	0.14	0.987	203	1.33	-0.09	0.976	-2	-0.05	-0.23	0.599
C62008	209	1.35	-0.03	0.983	204	1.32	-0.16	0.989	-5	-0.03	-0.13	0.996
C62101	230	1.03	0.30	0.976	223	1.10	-0.06	0.991	-7	0.07	-0.36	0.992
C62105	231	1.08	0.19	0.981	222	1.03	-0.13	0.987	-9	-0.05	-0.32	0.989
C60109	233	0.93	0.17	0.980	227	0.96	-0.11	0.991	-6	0.03	-0.29	0.395
J62302	281	1.09	0.33	0.983	277	1.07	0.22	0.993	-4	-0.02	-0.11	0.998
JN0202	252	1.25	0.12	0.994	244	1.26	-0.05	0.985	-8	0.01	-0.17	0.990
EH0203	245	1.28	0.12	0.986	237	1.31	0.06	0.993	-8	0.02	-0.06	0.992
EH0201	250	1.43	0.08	0.983	240	1.42	0.01	0.984	-10	-0.01	-0.06	0.986
EE0301	252	1.42	0.20	0.989	241	1.39	0.02	0.986	-11	-0.03	-0.17	0.983
LS0201	250	1.34	0.13	0.993	243	1.36	-0.14	0.989	-7	0.02	-0.27	0.991
TS0003	217	1.28	0.14	0.987	210	1.30	-0.10	0.986	-7	0.02	-0.24	0.993
TS0005	228	1.25	0.07	0.985	215	1.23	-0.13	0.985	-13	-0.03	-0.20	0.975
YS0001	222	1.20	0.09	0.989	211	1.20	0.01	0.979	-11	0.00	-0.08	0.984

(Sheet 4 of 4)

Table 5
Plan-Minus-Base Amplitude Differences
Steady-State Tide Tests

Station	Test 1 ft	Test 2 ft	Test 3 ft	Test 4 ft	Four Test Average ft
OCEAN	0.02	-0.06	-0.04	-0.01	-0.02
Sta 3	-0.03	0.02	-0.01	-0.03	-0.01
CB0001	-0.01	0.00	0.05	0.03	0.02
CB0004	0.02	-0.04	0.03	-0.05	-0.01
CB0008	0.02	-0.01	-0.08	-0.03	-0.02
CB0101	0.06	0.00	0.00	0.07	0.03
CB0105	0.01	-0.02	0.00	-0.05	-0.01
CB0109	0.05	-0.06	-0.02	0.03	0.00
JG0302	-0.02	-0.02	0.01	-0.02	-0.01
JN0202	0.00	0.01	0.00	0.01	0.00
EH0203	0.03	0.02	0.02	0.02	0.02
EH0901	0.00	-0.03	-0.05	-0.01	-0.02
EE0301	0.00	-0.01	-0.04	-0.03	-0.02
WB0201	0.03	0.00	-0.01	0.02	0.01
TS0003	0.02	-0.04	-0.06	0.02	-0.01
TS0005	0.04	N/A	N/A	-0.03	0.00
YS0001	0.06	-0.02	-0.06	0.00	0.00
Mean	0.018	-0.013	-0.015	-0.004	-0.003
Std Dev	0.027	0.023	0.037	0.033	0.032

Table 6
Plan-Minus-Base Mean Water Level Differences
Steady-State Tide Tests

Station	Unadjusted MWL Differences, ft				Adjusted MWL Differences, ft				Average	
	Test 1	Test 2	Test 3	Test 4	Average	Test 1	Test 2	Test 3	Test 4	
OCEAN	-0.06	0.03	0.04	-0.02	0.00	-0.06	0.03	0.04	-0.02	0.00
Sta 3	-0.14	-0.16	-0.11	-0.17	-0.14	0.00	-0.02	0.03	-0.03	0.00
CB0001	0.05	0.18	-0.12	-0.14	-0.01	0.19*	0.32*	0.02	0.-0	0.13
CB0004	-0.22	-0.08	0.10	-0.23	-0.11	-0.18	0.06	0.24*	-0.09	0.03
CB0008	-0.37	-0.14	-0.15	-0.13	-0.20	-0.23*	0.00	-0.01	0.01	-0.06
CB0101	-0.16	-0.13	-0.28	-0.36	-0.23	-0.02	0.01	-0.14*	-0.22*	-0.09
CB0105	-0.20	-0.18	-0.11	-0.32	-0.20	-0.06	-0.05	0.03	-0.18*	-0.06
CB0109	-0.33	-0.04	-0.21	-0.29	-0.22	-0.19*	0.10	-0.07	-0.15*	-0.08
JG0302	0.08	-0.07	-0.26	-0.11	-0.09	-0.06	0.07	-0.12*	0.03	0.05
JN0202	-0.05	-0.06	0.00	-0.17	-0.07	0.09	0.08	0.14*	-0.03	0.05
EH0203	-0.30	-0.06	-0.07	-0.06	-0.12	-0.16*	0.08	0.07	0.08	0.02
EH0901	-0.02	-0.11	-0.18	-0.06	-0.09	0.12*	0.03	-0.04	0.08	0.05
EE0301	-0.13	-0.11	0.01	-0.17	-0.10	0.01	0.03	0.15*	-0.03	0.04
WB0201	-0.15	-0.25	-0.30	-0.27	-0.24	-0.01	-0.11*	-0.16*	-0.13*	-0.10
TS0003	0.01	0.15	-0.13	-0.24	-0.05	0.15*	0.30*	0.01	0.10	0.09
TS0005	-0.20	-N/A	N/A	-0.20	-0.20	-0.06	N/A	N/A	-0.06	-0.06
YS0001	<u>-0.19</u>	<u>-0.07</u>	<u>-0.09</u>	<u>-0.08</u>	<u>-0.11</u>	<u>-0.05</u>	<u>0.07</u>	<u>0.05</u>	<u>0.06</u>	<u>0.03</u>
Mean	-0.14	-0.08	-0.13	-0.19	-0.14	0.00	0.06	0.01	-0.05	0.00
(excluding OCEAN)										

* Possible anomalous value due to unstable tripod.

Table 7
Steady-State Tides
Phase Angles Normalized to the Ocean

Station	Test 1 ****			Test 2 ****			Test 3 ****			Test 4 ****		
	Base deg	Plan df J	Diff deg	Base deg	Plan deg	Diff deg	Base deg	Plan deg	Diff deg	Base deg	Plan deg	Diff deg
				191°	191°	0°	191°	191°	0°	191°	191°	0°
OCEAN	191°	191°	0°									
Sta 3	234	232	-2	233	232	-1	231	231	0	235	230	-5
CB0001	202	204	2	206	202	-4	201	204	3	202	205	3
CB0004	202	205	3	205	205	0	209	207	-2	198	206	3
CB0008	203	207	4	210	206	-4	207	203	-4	203	208	5
CB0101	224	225	1	226	226	0	222	224	2	224	227	3
CB0105	224	225	1	232	225	-7	222	217	-5	225	226	1
CB0109	229	227	-2	231	229	-2	226	223	-3	227	231	4
JG0302	279	279	0	280	277	-3	278	279	1	275	281	6
JN0202	247	246	-1	245	241	-4	243	241	-2	246	248	2
EH0203	242	240	-2	241	237	-4	242	243	1	239	241	2
EH0901	244	244	0	246	243	-3	244	244	0	244	244	0
EE0301	245	243	-2	243	244	1	238	239	1	246	245	-1
NB0201	247	245	-2	244	243	-1	244	247	3	244	247	3
TS0003	209	212	3	213	212	-1	211	212	1	211	214	3
TS0005	220	221	1	N/A	219	N/A	N/A	223	N/A	222	219	-3
YS0001	213	213	0	214	214	0	210	209	-1	216	215	-1

Note: N/A = not available.

Table 8
Velocity Station Locations
Steady-State Velocity Tests

Station	Body of Water	Sampling Depths (ft below msl)	Latitude	Longitude
CB0001	Chesapeake Bay	4, 18, 32	36°56'12"	76°00'18"
CB0002	Chesapeake Bay	4,20,35,54,71	36°57'30"	76°00'05"
CB0004	Chesapeake Bay	4, 16, 28	37°00'06"	75°59'30"
CB0006	Chesapeake Bay	4, 15	37°02'00"	75°59'06"
CB0008	Chesapeake Bay	4, 24, 43	37°03'18"	75°58'48"
CB0009	Chesapeake Bay	4, 16	37°04'37"	75°58'36"
CB0101	Chesapeake Bay	4, 13	37°05'58"	76°14'43"
CB0103	Chesapeake Bay	4, 14, 24	37°07'05"	76°12'15"
CB0105	Chesapeake Bay	4, 20, 37	37°08'36"	76°08'59"
CB0107	Chesapeake Bay	4, 15, 27	37°10'36"	76°04'37"
CB0109	Chesapeake Bay	4, 39, 75	37°11'48"	76°02'01"
CB0110	Chesapeake Bay	4, 15	37°12'08"	76°01'32"
AC0002	Atlantic Ocean Channel	4,27,49,54*	36°54'06"	75°54'33"
TS0003	Thimble Shoal Channel	4,26,56,51*	36°58'21"	76°06'39"
TS0005	Thimble Shoal Channel	4,27,50,55*	37°00'24"	76°14'39"
YS0001	York Spit Channel	4, 25, 45	37°02'33"	76°04'31"
JG0101	James River	4, 11	36°58'54"	76°17'36"
JG0102	James River	4, 26, 48	36°59'36"	76°17'54"
JG0103	James River	4,22,44,66,83	37°00'00"	76°18'12"
JG0311	James River	4, 11	37°03'06"	76°36'16"
JG0302	James River	4, 16, 27	37°03'30"	76°35'36"
JG0321	James River	4	37°04'11"	76°36'15"
JN0202	James River	4, 12	36°55'23"	76°25'46"
JN0203	James River	4, 20	36°56'24"	76°25'22"
JN0204	James River	4,26,48,55*	36°57'04"	76°25'07"
EH0202	Elizabeth River	4,25,46,55*	36°53'15"	76°20'04"
EH0203	Elizabeth River	4, 22, 40	36°53'14"	76°20'16"
EH0501	Elizabeth River	4,22,39,45*	36°50'34"	76°17'41"
EH0701	Elizabeth River	4,19,35,40*	36°47'05"	76°18'13"
EH0901	Elizabeth River	4, 19, 35	36°45'18"	76°17'44"
EE0301	East Branch Elizabeth River	4, 21	36°50'13"	76°14'48"
WB0201	West Branch Elizabeth River	4, 13	36°51'14"	76°21'20"

* Additional depths samples during plan test only.

Table 9A
 TEST 1
 200,000 cfs, +2.4 ft Ocean Tide Amplitude

STATION	DEPTH FT	>>>>> BASE			>>>>> TEST			>>>>> PLAN			>>>>> TEST			>>>>> PLAN - MINUS-BASE<<		
		PHASE DEG	AMP FPS	MEAN FPS	R-SQUARE	PHASE DEG	AMP FPS	MEAN FPS	R-SQUARE	PHASE DEG	AMP FPS	MEAN FPS	R-SQUARE	PHASE DEG	AMP FPS	MEAN FPS
CB00001	4	205.	2.84	-1.11	0.940	207.	2.73	-0.85	0.952	3.	-0.10	0.27				
CB00001	18	196.	2.63	-0.68	0.980	198.	2.50	-0.71	0.941	1.	-0.12	-0.03				
CB00001	32	170.	1.99	-0.55	0.791	165.	1.94	-0.46	0.947	-4.	-0.05	0.09				
CB00002	4	205.	2.10	-0.72	0.938	213.	1.93	-0.70	0.956	8.	-0.17	0.02				
CB00002	20	204.	2.51	-0.31	0.895	214.	1.94	-0.57	0.929	9.	-0.57	-0.26				
CB00002	35	206.	2.55	0.34	0.915	204.	2.50	0.43	0.962	-2.	-0.05	0.09				
CB00002	54	202.	2.72	0.29	0.913	197.	2.45	0.38	0.977	-4.	-0.27	0.08				
CB00002	71	194.	2.29	0.30	0.911	169.	1.70	0.20	0.934	-5.	-0.59	-0.10				
CB00004	4	206.	2.03	-0.62	0.945	209.	2.20	-0.63	0.928	3.	0.17	-0.01				
CB00004	16	203.	2.36	-0.29	0.963	209.	2.42	-0.28	0.956	6.	0.06	0.02				
CB00004	28	187.	2.13	0.29	0.952	189.	2.08	0.36	0.965	3.	-0.05	0.08				
CB00005	4	206.	3.38	-0.10	0.928	211.	3.94	-0.85	0.969	5.	0.56	-0.74				
CB00005	15	204.	2.62	-0.18	0.952	209.	3.09	-0.33	0.955	4.	0.47	-0.16				
CB00008	4	213.	0.97	-0.20	0.956	214.	3.49	-0.74	0.979	0.	2.53	-0.53				
CB00008	24	203.	0.86	-0.08	0.963	203.	3.03	-0.30	0.981	0.	2.17	-0.22				
CB00008	43	189.	0.60	0.06	0.942	191.	2.30	-0.09	0.950	2.	1.70	-0.14				
CB00009	4	191.	4.87	-0.39	0.956	193.	4.52	-0.42	0.962	2.	-0.35	-0.03				
CB00009	16	187.	4.64	-0.31	0.977	191.	3.94	-0.21	0.986	4.	-0.71	0.10				
CB0101	4	252.	2.31	-0.44	0.965	256.	2.21	-0.48	0.975	4.	-0.11	-0.03				
CE1101	13	250.	1.60	-0.17	0.960	260.	1.84	-0.25	0.960	11.	0.25	-0.08				
CB0103	4	278.	1.85	-0.29	0.885	273.	1.79	-0.32	0.958	-5.	-0.07	-0.03				
CB0103	14	267.	1.93	-0.24	0.969	270.	1.86	-0.26	0.970	3.	-0.07	-0.02				
CB0103	24	250.	1.65	-0.16	0.950	261.	1.34	-0.14	0.914	11.	-0.30	0.02				
CB0105	4	283.	2.06	-0.13	0.945	274.	1.96	-0.10	0.926	-10.	-0.11	0.03				
CB0105	20	253.	2.06	0.26	0.939	255.	1.99	0.23	0.941	3.	-0.07	-0.04				
CB0105	37	228.	1.22	0.25	0.913	234.	1.53	0.47	0.925	5.	0.26	0.22				
CB0107	4	279.	2.35	-0.37	0.946	268.	2.24	-0.33	0.946	-11.	-0.11	0.04				
CB0107	15	280.	2.35	0.07	0.973	267.	2.37	0.13	0.939	-15.	-0.29	0.06				
CB0107	27	265.	1.58	0.41	0.928	258.	1.47	0.39	0.876	-9.	-2.12	-0.61				
CB0109	4	259.	2.12	-0.62	0.945	268.	2.17	-0.71	0.971	3.	2.35	-0.09				
CB0109	39	243.	1.72	0.52	0.892	251.	1.74	0.31	0.943	7.	0.02	-0.22				
CB0109	75	182.	0.95	0.63	0.783	194.	0.72	0.44	0.782	12.	-0.24	-0.19				

(Continued)

(Sheet 1 of 12)

Table 9e (continued)

STATION	DEPTH FT	>>>> BASE			<<<< TEST			>> PLAN			<<<< TEST			>>PLAN-MINUS-BASE<<		
		PHASE DEG	AMP FPS	MEAN R-SQUARE	PHASE DEG	AMP FPS	MEAN R-SQUARE									
CBD110	4	250.	2.62	-0.39	0.357	253.	2.49	-0.52	0.950	3.	-0.13	-0.11				
CBD110	15	243.	2.61	-0.22	0.616	247.	2.61	-0.37	0.965	4.	0.09	-0.04				
AC00002	4	231.	1.69	-0.95	0.879	231.	0.69	-0.86	0.876	1.	-0.20	-0.00				
AC00002	27	207.	1.76	0.13	0.611	225.	0.64	0.32	0.906	19.	-0.24	0.09				
AC00002	49	228.	1.65	0.76	0.642	218.	0.59	0.31	0.900	-10.	-0.06	-0.04				
AC00002	54	**	**	**	**	209.	0.63	0.30	0.933	**	**	**				
TS00003	4	210.	2.95	-0.47	0.943	208.	2.52	-0.45	0.953	-10.	-0.43	0.02				
TS00003	26	241.	2.59	0.78	0.683	258.	2.19	0.38	0.971	-13.	-0.31	0.00				
TS00003	45	245.	2.67	0.35	0.628	232.	2.61	0.59	0.939	-13.	-0.26	0.18				
TS00003	51	**	**	**	**	234.	2.63	0.50	0.947	**	**	**				
TS00005	4	242.	2.78	-1.11	0.657	238.	2.96	-1.12	0.964	-4.	-0.12	-0.01				
TS00005	27	237.	2.41	-0.17	0.747	227.	2.06	-0.15	0.905	-10.	-0.35	0.07				
TS00005	50	218.	1.82	0.28	0.670	205.	1.73	1.88	0.887	-13.	0.17	-0.20				
TS00005	55	**	**	**	**	227.	1.46	1.78	0.857	**	**	**				
YS00001	4	254.	0.63	0.67	0.617	252.	3.22	-0.08	0.892	-2.	-0.41	-0.16				
YS00001	25	256.	0.21	0.56	0.560	245.	3.65	0.52	0.817	-10.	-0.22	-0.16				
YS00001	45	251.	0.20	0.56	0.560	247.	2.62	0.51	0.873	-9.	0.07	-0.01				
JG0101	4	212.	2.14	-0.24	0.747	201.	2.93	-0.50	0.955	-11.	0.24	-0.36				
JG0101	11	214.	2.12	-0.24	0.747	204.	2.94	-0.35	0.934	-13.	-0.22	-0.13				
JG0102	4	212.	2.12	-0.24	0.747	215.	2.71	-0.49	0.954	6.	-0.83	0.14				
JG0102	26	251.	0.20	0.56	0.560	247.	2.62	0.47	0.866	-2.	-0.33	0.05				
JG0102	42	160.	2.12	-0.24	0.747	201.	2.93	-0.10	0.956	-11.	0.24	-0.36				
JG0103	4	211.	2.12	-0.24	0.747	202.	2.94	-0.35	0.934	-13.	-0.22	-0.13				
JG0103	22	212.	2.12	-0.24	0.747	203.	2.71	-0.49	0.954	6.	-0.83	0.14				
JG0103	44	195.	2.12	-0.24	0.747	204.	2.71	-0.47	0.866	-2.	-0.33	0.05				
JG0103	65	164.	2.12	-0.24	0.747	205.	2.93	-0.10	0.956	-11.	0.24	-0.36				
JG0103	85	207.	2.12	-0.24	0.747	206.	2.94	-0.35	0.934	-13.	-0.22	-0.13				
JG0301	4	263.	2.65	0.11	0.683	251.	2.52	0.38	0.971	6.	-0.34	0.52				
JG0301	11	285.	2.64	0.11	0.683	263.	2.52	0.38	0.971	-11.	0.24	-0.36				
JG0302	4	16.	2.64	0.11	0.683	251.	2.52	0.38	0.971	-11.	0.24	-0.36				
JG0302	16	21.	2.64	0.11	0.683	263.	2.52	0.38	0.971	-11.	0.24	-0.36				
JG0302	21	261.	2.64	0.11	0.683	251.	2.52	0.38	0.971	-11.	0.24	-0.36				

Correct 2 of 12)

(Continued)

Table 9A (Concluded)

STATION	DEPTH FT	>>>>> BASE			TEST <<<<<			>>>>> PLAN			>>>>> TEST <<<<<			>>PLAN-MINUS-BASE<<		
		PHASE DEG	AMP FPS	MEAN FPS	R-SQUARE FPS	PHASE DEG	AMP FPS	MEAN FPS	R-SQUARE FPS	PHASE DEG	AMP FPS	MEAN FPS	R-SQUARE FPS	PHASE DEG	AMP FPS	MEAN FPS
JG0321	4	262.	2.76	-0.51	0.959	269.	2.31	-0.48	0.949	7.	-0.46	0.84				
JNB0202	4	229.	1.04	0.00	0.916	220.	1.26	-0.15	0.920	-9.	0.21	-0.15				
JNB0202	12	209.	1.25	-0.07	0.932	206.	0.78	-0.00	0.887	-3.	-0.48	0.06				
JNB0203	4	240.	1.90	-0.51	0.946	250.	1.73	-0.50	0.916	10.	-0.17	0.00				
JNB0203	20	228.	1.35	-0.14	0.952	226.	1.31	-0.22	0.938	-2.	-0.04	-0.08				
JNB0204	4	231.	2.63	-0.50	0.883	246.	2.89	-1.13	0.967	14.	0.26	-0.63				
JNB0204	25	220.	2.69	0.05	0.950	226.	2.52	0.10	0.948	6.	-0.17	0.05				
JH0204	48	221.	2.19	0.42	0.923	219.	2.23	0.62	0.946	-2.	0.04	0.21				
JN0204	55	*****	*****	0.923	211.	1.91	0.95	0.889	*****	*****	*****	*****				
EH0202	4	166.	1.33	-0.32	0.750	191.	1.20	-0.25	0.802	5.	-0.12	0.07				
EH0202	25	190.	1.09	-0.06	0.789	188.	1.05	0.05	0.825	-2.	-0.05	0.12				
EH0202	45	147.	1.27	0.13	0.840	157.	0.29	-0.07	0.301	10.	-0.99	-0.20				
EH0202	55	*****	*****	0.840	115.	0.26	0.03	0.220	*****	*****	*****	*****				
EH0203	4	173.	1.11	-0.25	0.624	183.	1.09	-0.27	0.823	5.	-0.02	-0.02				
EH0203	22	170.	1.08	0.01	0.805	176.	0.99	0.17	0.687	7.	-0.09	0.16				
EH0203	40	152.	1.30	0.34	0.770	163.	0.44	0.19	0.411	11.	-0.85	-0.15				
EH0501	4	206.	0.71	-0.15	0.678	195.	0.57	-0.14	0.552	-10.	-0.14	0.01				
EH0501	22	192.	0.60	0.08	0.417	190.	0.67	-0.07	0.788	-2.	0.07	-0.15				
EH0501	39	182.	0.55	0.08	0.700	157.	0.67	-0.14	0.765	-25.	0.12	-0.22				
EH0501	45	*****	*****	0.700	163.	0.62	-0.00	0.689	*****	*****	*****	*****				
EH0701	4	218.	1.09	-0.19	0.738	208.	0.63	0.03	0.585	-10.	-0.45	0.22				
EH0701	19	176.	0.79	-0.09	0.442	165.	0.71	-0.06	0.430	-11.	-0.08	0.03				
EH0701	35	183.	0.92	-0.10	0.463	171.	0.65	-0.01	0.490	-12.	-0.26	0.09				
EH0701	40	*****	*****	0.463	162.	0.51	0.12	0.690	*****	*****	*****	*****				
EH0901	4	189.	1.15	-0.59	0.720	200.	0.91	-0.33	0.759	11.	-0.24	0.26				
EH0901	19	171.	0.44	-0.13	0.269	154.	0.20	-0.00	0.161	-17.	-0.24	0.12				
EH0901	35	161.	0.23	-0.02	0.211	174.	0.07	-0.01	0.035	13.	-0.15	0.00				
EE0301	4	198.	0.73	-0.03	0.642	197.	1.02	0.03	0.669	-1.	0.23	0.04				
EE0301	21	163.	0.32	0.05	0.409	184.	0.17	0.03	0.142	4.	-0.15	-0.02				
UR0301	4	197.	1.77	0.21	0.915	187.	1.61	0.04	0.869	-10.	0.12	-0.18				
UG0201	13	133.	1.40	0.23	0.303	165.	1.61	0.17	0.894	-8.	0.21	-0.06				

(Sheet 3 of 12)

Table 9B
TEST 2

200,000 cfs., r1.5 ft Ocean Tide Amplitude

STATION	DEPTH (FT)	>>>>> BASE			TEST <<<<<			>>>>> PLAN			TEST <<<<<			>>PLAN-MINUS-BASE<<		
		PHASE DEG	AMP FPS	R-SQUARE	MEAN FPS	PHASE DEG	AMP FPS	R-SQUARE	MEAN FPS	PHASE DEG	AMP FPS	R-SQUARE	MEAN FPS	PHASE DEG	AMP FPS	R-SQUARE
CB0001	4	219.	1.74	-0.87	0.890	237.	1.69	-0.76	0.826	18.	-0.05	0.12				
CB0001	18	185.	1.13	-0.24	0.300	192.	1.23	-0.27	0.901	7.	0.09	-0.03				
CB0001	32	168.	1.27	-0.03	0.650	179.	1.39	-0.15	0.937	10.	0.13	-0.12				
CB0002	4	230.	1.37	-0.75	0.969	249.	1.41	-0.07	0.782	18.	0.03	0.69				
CB0002	20	224.	1.54	0.14	0.944	233.	1.36	0.28	0.883	9.	-0.18	0.14				
CB0002	35	218.	1.47	0.23	0.936	228.	1.23	0.35	0.888	10.	-0.24	0.13				
CB0002	54	211.	1.56	0.26	0.941	223.	1.39	0.24	0.948	12.	-0.19	-0.02				
CB0002	71	190.	1.33	0.25	0.936	186.	1.10	0.23	0.919	-4.	-0.23	-0.02				
CB0004	4	219.	1.38	-0.48	0.943	227.	1.70	-0.86	0.908	8.	0.32	-0.38				
CB0004	16	214.	1.32	0.02	0.864	220.	1.64	-0.08	0.927	6.	0.32	-0.10				
CB0004	28	192.	1.06	0.05	0.871	234.	1.53	0.08	0.942	12.	0.46	0.02				
CB0005	4	265.	1.83	-0.71	0.841	286.	1.96	-0.89	0.971	3.	0.13	-0.18				
CB0005	15	210.	1.74	-0.12	0.931	221.	1.61	-0.11	0.967	11.	-0.13	0.01				
CB0008	4	222.	2.10	-0.70	0.918	236.	2.27	-0.88	0.888	14.	0.17	-0.18				
CB0008	24	200.	2.01	0.10	0.944	216.	1.98	-0.19	0.951	16.	-0.03	-0.29				
CB0008	43	202.	1.25	0.28	0.811	200.	1.32	0.33	0.827	-2.	0.07	0.05				
CB0009	4	205.	3.90	-0.37	0.957	196.	3.54	-0.32	0.940	-10.	-0.36	0.05				
CB0009	16	198.	2.84	0.05	0.957	193.	2.69	0.02	0.943	-5.	-0.15	-0.03				
CB0101	4	247.	1.95	-0.41	0.959	259.	1.46	-0.44	0.924	12.	-0.39	-0.03				
CB0101	13	238.	1.24	-0.15	0.933	244.	1.03	-0.09	0.852	6.	-0.21	0.07				
CB0103	4	258.	1.12	-0.43	0.947	266.	0.75	-0.32	0.618	-2.	-0.37	0.08				
CB0103	14	266.	1.15	-0.41	0.917	266.	0.75	-0.32	0.618	-8.	-0.39	0.09				
CB0103	24	218.	0.99	-0.87	0.863	216.	0.53	-0.12	0.453	-2.	-0.46	-0.05				
CB0105	4	258.	1.70	-0.48	0.958	262.	1.10	-0.07	0.957	4.	-0.52	0.33				
CB0105	20	250.	1.61	-0.15	0.968	241.	1.14	0.42	0.941	-9.	-0.47	0.58				
CB0105	37	224.	1.16	0.34	0.753	220.	0.91	0.31	0.607	-5.	-0.25	-0.03				
CB0107	4	252.	1.44	-0.30	0.850	216.	1.20	-0.23	0.682	15.	-0.22	0.07				
CB0107	15	261.	1.28	-0.01	0.793	262.	1.24	-0.03	0.935	1.	-0.04	0.00				
CB0107	27	239.	0.92	0.15	0.638	250.	0.62	0.14	0.739	11.	-0.30	-0.03				
CB0109	4	258.	1.02	-0.47	0.663	256.	1.12	-0.50	0.832	-2.	0.15	-0.07				
CB0109	39	223.	1.56	0.38	0.613	232.	1.50	0.17	0.850	9.	-0.05	-0.12				
CB0109	75	195.	1.64	-0.14	0.795	214.	1.08	-0.07	0.869	23.	0.03	0.03				

(Continued)

(Sheet 4 of 12)

Table 9B (Continued)

STATION	DEPTH FT	>>>>> BASE				>>>>> TEST				>>>>> PLAN				>>>>> TEST				>>>>> R-SQUARE				>>>>> <<<<<			
		PHASE DEG	AMP FPS	MEAN FPS	R-SQUARE	PHASE DEG	AMP FPS	MEAN FPS	R-SQUARE	PHASE DEG	AMP FPS	MEAN FPS	R-SQUARE												
CB0110	4	269.	1.65	-0.33	0.924	265.	1.50	-0.43	0.935	5.	-0.14	-0.14	-0.10	5.	-0.13	0.916	-5.	-0.13	0.916	-0.15	5.	-0.13	0.916	-0.15	
CB0110	15	259.	1.16	0.02	0.875	254.	1.20	-0.23	0.473	11.	-0.19	-0.19	-0.04	11.	-0.23	0.473	-10.	-0.19	0.473	-0.04	11.	-0.23	0.473	-0.04	
AC0002	4	182.	0.56	-0.19	0.632	193.	0.37	-0.23	0.44	0.13	0.525	-0.18	-0.01	0.13	0.44	0.13	0.525	-10.	-0.18	0.525	-0.01	0.13	0.44	0.13	0.525
AC0002	27	221.	0.62	0.14	0.809	211.	0.53	0.14	0.581	0.14	0.581	-0.02	-0.07	0.14	0.53	0.14	0.581	7.	-0.02	0.581	-0.07	0.14	0.53	0.14	0.581
AC0002	49	213.	0.55	0.22	0.769	220.	0.42	0.10	0.437	0.10	0.437	****	****	0.42	0.10	0.437	0.10	0.437	****	****	0.42	0.10	0.437	0.10	0.437
AC0002	54	***	***	***	0.768	219.	0.42	0.10	0.437	0.10	0.437	****	****	0.42	0.10	0.437	0.10	0.437	****	****	0.42	0.10	0.437	0.10	0.437
TS0003	4	237.	1.60	-0.49	0.876	222.	1.42	-0.40	0.878	15.	-0.18	-0.18	-0.09	15.	-0.18	0.878	-14.	-0.18	0.878	-0.09	15.	-0.18	0.878	-0.09	
TS0003	26	237.	1.68	0.37	0.948	222.	1.70	0.29	0.944	14.	0.02	0.02	-0.08	14.	0.02	0.944	-14.	0.02	0.944	-0.08	14.	0.02	0.944	-0.08	
TS0003	46	235.	1.44	0.44	0.922	229.	1.69	0.50	0.944	6.	0.25	0.25	0.06	6.	0.25	0.944	-6.	0.25	0.944	0.06	6.	0.25	0.944	0.06	
TS0003	51	***	***	***	0.922	227.	1.51	0.49	0.948	10.	-0.19	-0.19	-0.09	10.	-0.19	0.948	-10.	-0.19	0.948	-0.09	10.	-0.19	0.948	-0.09	
TS0005	4	227.	1.29	-1.00	0.833	237.	1.10	-0.89	0.903	10.	-0.19	-0.19	-0.11	10.	-0.19	0.903	-10.	-0.19	0.903	-0.11	10.	-0.19	0.903	-0.11	
TS0005	27	216.	1.12	-0.07	0.825	231.	1.47	0.17	0.867	15.	0.35	0.35	0.25	15.	0.35	0.867	-15.	0.35	0.867	0.25	15.	0.35	0.867	0.25	
TS0005	50	218.	1.50	1.31	0.839	236.	1.64	1.27	0.763	17.	0.13	0.13	-0.04	17.	0.13	0.763	-17.	0.13	0.763	-0.04	17.	0.13	0.763	-0.04	
TS0005	55	***	***	***	0.839	232.	1.59	1.23	0.798	6.	-0.31	-0.31	-0.09	6.	-0.31	0.798	-6.	-0.31	0.798	-0.09	6.	-0.31	0.798	-0.09	
Y50001	4	219.	1.80	-0.23	0.737	226.	1.49	-0.32	0.535	6.	-0.31	-0.31	-0.09	6.	-0.31	0.535	-6.	-0.31	0.535	-0.09	6.	-0.31	0.535	-0.09	
Y50001	25	224.	1.81	0.26	0.895	239.	2.32	0.96	0.946	15.	0.51	0.51	0.67	15.	0.51	0.946	-15.	0.51	0.946	0.67	15.	0.51	0.946	0.67	
Y50001	45	223.	2.27	1.07	0.917	235.	2.02	0.82	0.948	12.	-0.25	-0.25	-0.25	12.	-0.25	0.948	-12.	-0.25	0.948	-0.25	12.	-0.25	0.948	-0.25	
JG0101	4	213.	2.45	-0.61	0.942	219.	2.24	-0.68	0.950	6.	-0.20	-0.20	-0.07	6.	-0.20	0.950	-6.	-0.20	0.950	-0.07	6.	-0.20	0.950	-0.07	
JG0101	11	206.	1.97	-0.30	0.948	201.	1.71	-0.39	0.934	-5.	-0.26	-0.26	-0.09	-5.	-0.26	0.934	-5.	-0.26	0.934	-0.09	-5.	-0.26	0.934	-0.09	
JG0102	4	227.	2.62	-0.60	0.961	231.	2.73	-0.84	0.969	4.	0.10	0.10	-0.25	4.	0.10	0.969	-4.	0.10	0.969	-0.25	4.	0.10	0.969	-0.25	
JG0102	26	214.	2.02	-0.03	0.928	212.	1.96	-0.13	0.966	-2.	-0.06	-0.06	-0.09	-2.	-0.06	0.966	-2.	-0.06	0.966	-0.09	-2.	-0.06	0.966	-0.09	
JG0102	48	153.	1.07	0.13	0.717	158.	1.14	0.25	0.711	5.	0.07	0.07	0.12	5.	0.07	0.711	-5.	0.07	0.711	0.12	5.	0.07	0.711	0.12	
JG0103	4	213.	2.50	-0.58	0.698	225.	2.65	-0.73	0.815	11.	0.15	0.15	-0.15	11.	0.15	0.815	-11.	0.15	0.815	-0.15	11.	0.15	0.815	-0.15	
JG0103	22	207.	1.55	-0.15	0.838	211.	1.79	0.01	0.814	4.	-0.16	-0.16	-0.16	4.	-0.16	0.814	-4.	-0.16	0.814	-0.16	4.	-0.16	0.814	-0.16	
JG0103	44	193.	1.22	0.29	0.716	193.	1.50	0.34	0.868	10.	0.28	0.28	0.05	10.	0.28	0.868	-10.	0.28	0.868	0.05	10.	0.28	0.868	0.05	
JG0103	66	158.	1.38	0.50	0.861	164.	1.44	0.52	0.825	-4.	0.06	0.06	0.03	-4.	0.06	0.825	-4.	0.06	0.825	0.03	-4.	0.06	0.825	0.03	
JG0103	83	135.	0.97	0.46	0.502	143.	0.83	0.36	0.707	8.	-0.10	-0.10	-0.10	8.	-0.10	0.707	-8.	-0.10	0.707	-0.10	8.	-0.10	0.707	-0.10	
JG0311	4	261.	1.43	-0.25	0.960	267.	1.79	-0.39	0.968	6.	0.36	0.36	-0.05	6.	0.36	0.968	-6.	0.36	0.968	-0.05	6.	0.36	0.968	-0.05	
JG0311	11	249.	1.13	-0.23	0.912	265.	1.50	-0.19	0.967	17.	0.37	0.37	0.04	17.	0.37	0.967	-17.	0.37	0.967	0.04	17.	0.37	0.967	0.04	
JG0302	4	253.	1.38	-0.30	0.979	253.	1.75	-0.22	0.952	-4.	-0.03	-0.03	-0.07	-4.	-0.03	0.952	-4.	-0.03	0.952	-0.07	-4.	-0.03	0.952	-0.07	
JG0302	16	263.	1.43	-0.19	0.932	250.	1.24	-0.12	0.938	-13.	-0.19	-0.19	-0.12	-13.	-0.19	0.938	-13.	-0.19	0.938	-0.12	-13.	-0.19	0.938	-0.12	
JG0302	27	250.	0.62	-0.22	0.655	249.	0.75	-0.31	0.752	-9.	0.13	0.13	-0.13	-9.	0.13	0.752	-9.	0.13	0.752	-0.13	-9.	0.13	0.752	-0.13	

(continued)

(Sheet 5 of 12)

Table 9b (concluded)

STATION	DEPTH	>>>>> BASE			>>>>> TEST			<<<<< PLAN			<<<<< TEST			<<<<< R-SQUARE			>>>>> >>>>> >>>>>			
		PHASE	AMP	MÉAN	R-SQUARE	PHASE	AMP	MÉAN	R-SQUARE	PHASE	AMP	MÉAN	R-SQUARE	PHASE	AMP	MÉAN	R-SQUARE	PHASE	AMP	MÉAN
		DEG	FPS				DEG	FPS			DEG	FPS			DEG	FPS			DEG	FPS
JG0321	4	269.	1.65	-0.34	0.970	268.	1.74	-0.37	0.977	-1.	0.09	-0.02								
JN0202	4	230.	0.84	-0.02	0.295	222.	0.97	-0.14	0.865	-9.	0.06	-0.11								
JN0202	12	198.	0.62	0.03	0.794	262.	0.62	-0.01	0.870	4.	-0.00	-0.04								
JN0203	4	225.	1.42	-0.59	0.932	221.	1.23	-0.53	0.896	-4.	-0.18	0.07								
JN0203	20	203.	0.87	-0.05	0.871	213.	0.90	-0.12	0.703	13.	0.04	-0.06								
JN0204	4	220.	1.69	-0.67	0.966	238.	2.16	-0.71	0.695	18.	0.29	-0.04								
JN0204	26	227.	1.70	0.16	0.949	226.	1.67	0.17	0.887	-1.	-0.02	0.01								
JN0204	48	195.	1.57	1.13	0.868	289.	1.62	1.22	0.711	14.	0.05	0.09								
JN0204	55	***	***	***	0.368	288.	1.55	1.22	0.688	****	****	****								
EH0202	4	164.	1.28	-0.25	0.804	171.	0.95	-0.21	0.770	-12.	-0.13	0.04								
EH0202	25	180.	0.32	0.14	0.442	189.	0.74	0.24	0.802	9.	0.42	0.10								
EH0202	46	249.	0.11	-0.02	0.115	267.	0.58	-0.04	0.453	19.	0.47	-0.03								
EH0202	55	***	***	***	0.115	250.	0.30	-0.06	0.164	****	****	****								
EH0203	4	154.	0.95	-0.33	0.904	153.	0.61	-0.13	0.749	-0.	-0.34	0.20								
EH0203	22	149.	0.61	0.28	0.546	159.	0.50	0.27	0.606	10.	-0.02	-0.02								
EH0203	40	63.	0.15	0.02	0.214	49.	0.22	-0.05	0.163	-13.	0.09	-0.08								
EH0501	4	186.	0.26	-0.01	0.531	289.	0.37	-0.03	0.422	23.	0.11	-0.02								
EH0501	22	213.	0.35	-0.05	0.464	209.	0.24	0.01	0.262	-4.	-0.11	0.06								
EH0501	39	175.	0.64	-0.25	0.879	168.	0.36	-0.12	0.383	-57.	-0.28	0.13								
EH0501	45	***	***	***	0.839	131.	0.43	-0.12	0.512	****	****	****								
EH0701	4	225.	0.39	-0.26	0.711	226.	0.30	-0.12	0.686	-5.	-0.09	0.16								
EH0701	19	190.	0.67	-0.24	0.677	179.	0.59	-0.12	0.754	-11.	-0.08	0.12								
EH0701	35	164.	0.50	0.37	0.416	159.	0.45	-0.11	0.810	-5.	0.33	-0.15								
EH0701	40	***	***	***	0.410	261.	0.26	-0.13	0.795	****	****	****								
EH0701	4	215.	0.64	-0.39	0.663	121.	0.62	-0.26	0.616	5.	-0.01	0.04								
EH0901	19	262.	0.37	0.05	0.519	160.	0.29	-0.05	0.520	-5.	-0.08	-0.15								
EH0901	35	136.	0.02	-0.01	0.637	267.	0.03	0.01	0.694	63.	0.00	0.02								
EE0301	4	195.	0.42	0.10	0.531	168.	0.45	0.37	0.445	13.	-0.15	-0.04								
EE0301	21	184.	0.83	-0.02	0.176	124.	0.22	-0.16	0.353	-10.	-0.62	-0.13								
WB0201	4	164.	1.04	0.12	0.569	175.	1.02	0.65	0.952	10.	-0.02	0.05								
WB0201	13	152.	6.82	0.43	0.836	155.	6.67	0.43	0.428	3.	-0.15	-0.13								

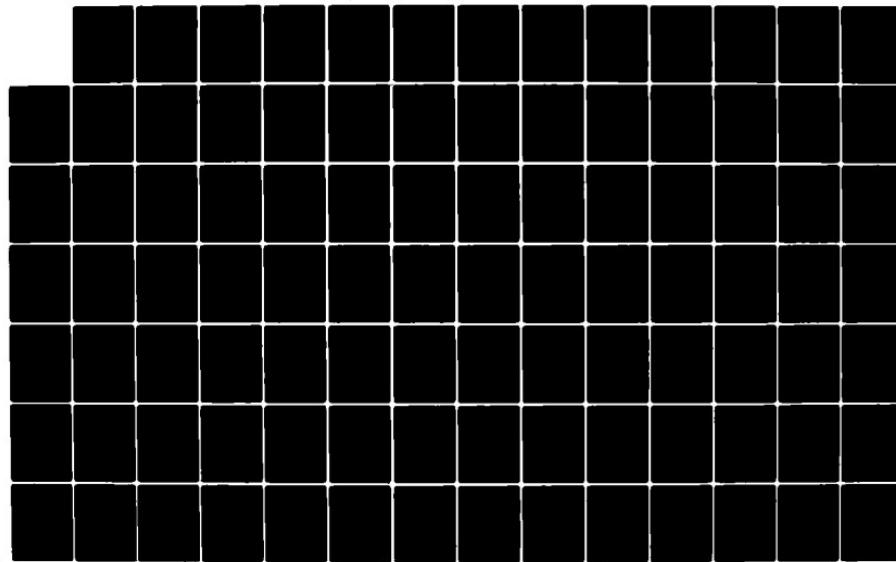
(Sheet 6 of 12)

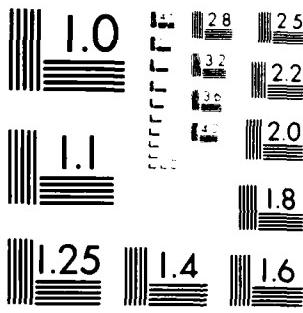
AD-A134 563 NORFOLK HARBOR AND CHANNELS DEEPENING STUDY REPORT 1
PHYSICAL MODEL RESUL..(U) ARMY ENGINEER WATERWAYS
EXPERIMENT STATION VICKSBURG MS HYDRA.

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MICROCOPY RESOLUTION TEST CHART
Nikon Model 2500-A
Nikon Corporation

Table 9C

TEST 3

70,000 cfs, +2.4 ft Ocean Tide Amplitude

STATION	DEPTH FT	>>>> BASE TEST <<<<<			>>>>> PLAN TEST <<<<<			>>PLAN-MINUS-BASE<<				
		PHASE DEG	AMP FPS	MEAN FPS	PHASE DEG	AMP FPS	MEAN FPS	PHASE DEG	AMP FPS	MEAN FPS		
CB0001	4	201.	2.65	-0.93	0.973	206.	2.38	-0.67	0.974	5.	-0.27	0.26
CB0001	18	194.	2.37	-0.55	0.943	196.	2.21	-0.39	0.882	2.	-0.16	0.15
CB0001	32	183.	2.04	-0.49	0.904	180.	1.77	-0.38	0.908	-3.	-0.26	0.11
CB0002	4	212.	2.54	-0.44	0.932	222.	2.48	-0.29	0.887	11.	-0.06	0.15
CB0002	20	204.	2.45	0.09	0.979	215.	2.56	0.04	0.942	11.	0.11	-0.05
CB0002	35	202.	2.47	0.26	0.974	208.	2.57	0.24	0.965	6.	0.10	-0.02
CB0002	54	196.	2.47	0.34	0.977	201.	2.47	0.23	0.936	5.	0.00	-0.12
CB0002	71	187.	1.91	0.09	0.935	194.	2.19	0.08	0.923	7.	0.29	-0.01
CB0004	4	205.	2.79	-0.24	0.937	210.	2.36	-0.28	0.899	5.	-0.43	-0.04
CB0004	16	196.	2.46	0.04	0.958	202.	2.33	-0.11	0.928	6.	-0.13	-0.14
CB0004	28	204.	1.72	0.03	0.956	195.	1.86	-0.02	0.901	-10.	0.14	-0.05
CB0006	4	211.	3.73	-0.48	0.979	218.	3.46	-0.55	0.931	7.	-0.27	-0.07
CB0006	15	210.	2.83	-0.48	0.967	211.	2.88	-0.28	0.966	1.	0.05	0.12
CB0008	4	203.	3.40	-0.58	0.980	218.	3.54	-0.54	0.981	15.	0.14	0.03
CB0008	24	201.	3.16	-0.28	0.978	211.	3.36	-0.23	0.976	9.	0.20	0.05
CB0008	43	195.	2.93	-0.08	0.982	204.	2.69	0.04	0.976	10.	-0.23	0.12
CB0009	4	193.	5.12	-0.40	0.983	199.	4.44	-0.11	0.972	6.	-0.67	0.29
CB0009	16	191.	4.60	-0.13	0.987	199.	4.27	0.04	0.965	8.	-0.34	0.16
CB0101	4	235.	1.85	-0.22	0.968	229.	1.68	-0.16	0.933	-6.	-0.18	0.06
CB0101	13	235.	1.60	-0.16	0.976	231.	1.53	-0.19	0.933	-4.	-0.08	-0.03
CB0103	4	249.	2.15	-0.27	0.951	244.	1.93	-0.28	0.972	-5.	-0.22	-0.02
CB0103	14	249.	2.05	-0.08	0.955	243.	1.85	-0.11	0.956	-5.	-0.19	-0.03
CB0103	24	243.	1.85	-0.10	0.976	232.	1.42	-0.08	0.964	-11.	-0.43	0.02
CB0105	4	237.	2.11	0.00	0.969	253.	1.81	-0.01	0.948	16.	-0.30	-0.01
CB0105	20	231.	1.82	0.19	0.930	243.	1.80	0.15	0.927	12.	-0.01	-0.04
CB0105	37	220.	1.59	0.38	0.877	224.	1.20	0.32	0.663	4.	-0.39	-0.06
CB0107	4	240.	2.22	-0.13	0.949	249.	2.46	-0.17	0.930	10.	0.24	-0.04
CB0107	15	244.	2.14	0.28	0.828	246.	2.27	0.14	0.946	3.	0.13	-0.14
CB0107	27	235.	1.79	0.30	0.967	245.	1.73	0.33	0.943	10.	-0.07	0.03
CB0109	4	234.	1.95	-0.26	0.949	252.	2.17	-0.79	0.805	18.	0.23	-0.54
CB0109	39	225.	1.74	0.40	0.916	228.	1.72	0.45	0.865	3.	-0.02	0.05
CB0109	75	172.	0.55	0.78	0.621	185.	0.26	0.84	0.167	14.	-0.30	0.06

(Continued)

(Sheet 7 of 12)

Table 9C (Continued)

STATION	DEPTH FT	>>>>> BASE		TEST <<<<<		>>>>> PLAN		TEST <<<<<		>>>>> PHASE		>>>>> AMP		>>>>> MEAN		
		PHASE DEG	AMP FPS	MEAN FPS	R-SQUARE	PHASE DEG	AMP FPS	MEAN FPS	R-SQUARE	PHASE DEG	AMP FPS	MEAN FPS	R-SQUARE	PHASE DEG	AMP FPS	MEAN FPS
CB0110	4	224.	2.66	-0.48	0.962	236.	2.36	-0.50	0.944	12.	-0.30	-0.02				
CB0110	15	219.	2.32	-0.34	0.968	227.	2.16	-0.28	0.961	9.	-0.16	0.06				
AC0002	4	212.	1.12	-0.82	0.800	218.	0.72	-0.54	0.671	6.	-0.40	0.28				
AC0002	27	196.	1.19	0.17	0.932	200.	0.95	0.16	0.919	4.	-0.24	-0.01				
AC0002	49	184.	1.01	0.29	0.932	192.	1.14	0.28	0.934	8.	0.13	-0.01				
AC0002	54	**	**	**	0.932	193.	1.03	0.23	0.957	**	**	**				
TS0002	4	213.	2.98	-0.44	0.943	202.	2.76	-0.28	0.943	-11.	-0.22	0.16				
TS0003	26	219.	2.69	0.25	0.975	209.	2.53	0.44	0.891	-10.	-0.36	0.18				
TC3003	46	216.	2.53	0.34	0.952	210.	2.78	0.44	0.936	-6.	0.25	0.18				
TS0003	51	**	**	**	0.952	210.	2.68	0.32	0.940	**	**	**				
TS0003	4	195.	2.67	-0.72	0.975	201.	2.58	-0.63	0.960	5.	-0.29	0.08				
TS0005	27	201.	2.46	-0.07	0.958	200.	2.29	-0.22	0.980	-1.	-0.17	-0.15				
TS0005	50	194.	1.21	1.56	0.844	202.	1.70	1.28	0.911	8.	0.49	-0.29				
TS0005	55	**	**	**	0.844	193.	1.26	1.26	0.916	**	**	**				
YS0001	4	217.	3.40	0.22	0.599	230.	3.53	0.44	0.915	13.	0.12	0.22				
YS0001	25	209.	3.24	0.56	0.897	226.	3.18	0.70	0.946	17.	-0.14	0.14				
YS0001	45	215.	2.61	0.53	0.937	225.	2.72	0.78	0.949	10.	0.12	0.25				
JG0101	4	156.	2.72	-0.02	0.860	163.	2.41	0.08	0.841	7.	-0.31	0.18				
JG0101	11	152.	2.28	0.09	0.863	164.	2.17	0.00	0.850	12.	-0.11	-0.09				
JG0102	4	199.	3.68	-0.52	0.973	196.	3.01	-0.32	0.974	-1.	-0.67	0.20				
JG0102	26	195.	3.26	-0.41	0.979	196.	2.82	-0.32	0.970	0.	-0.44	0.08				
JG0102	48	193.	3.11	-0.20	0.962	192.	2.95	-0.20	0.964	-2.	-0.16	-0.00				
JG0103	4	185.	3.37	-0.27	0.955	192.	3.05	-0.40	0.959	7.	-0.32	-0.13				
JG0103	22	184.	2.95	-0.12	0.961	191.	2.49	-0.03	0.961	8.	-0.46	0.08				
JG0103	44	176.	2.44	-0.01	0.955	193.	2.67	0.11	0.915	17.	0.23	0.12				
JG0103	66	161.	2.27	0.39	0.797	175.	2.64	0.47	0.807	14.	0.37	0.08				
JG0103	83	154.	1.06	0.55	0.268	163.	1.29	0.48	0.464	9.	0.21	-0.07				
JG0311	4	251.	2.32	-0.54	0.885	246.	2.12	-0.28	0.976	-6.	-0.20	0.26				
JG0311	11	250.	1.92	-0.23	0.945	245.	2.00	-0.23	0.964	-5.	0.08	0.00				
JG0302	4	233.	2.54	-0.29	0.978	243.	2.17	-0.17	0.978	10.	-0.37	0.12				
JG0302	16	237.	2.21	-0.15	0.367	244.	1.98	-0.09	0.959	8.	-0.22	0.06				
JG0302	27	236.	1.74	-0.03	0.947	243.	1.74	-0.18	0.963	6.	-0.00	-0.07				

(Continued)

(Sheet 8 of 12)

Table 9C (Concluded)

STATION	DEPTH FT	>>>>> BASE TEST <<<<<			>>>>> PLAN TEST <<<<<			>>PLAN-MINUS-BASE<<				
		PHASE DEG	AMP FPS	MEAN FPS	PHASE DEG	AMP FPS	MEAN FPS	PHASE DEG	AMP FPS	MEAN FPS		
JG0321	4	238.	2.27	-0.38	0.949	243.	2.08	-0.34	0.958	5.	-0.19	0.04
JN0202	4	194.	1.64	-0.06	0.962	197.	1.38	0.03	0.868	3.	-0.26	0.09
JN0202	12	194.	1.37	0.05	0.942	193.	1.25	0.05	0.902	-0.	-0.13	-0.00
JN0203	4	221.	1.63	-0.40	0.864	223.	1.72	-0.48	0.879	3.	0.09	-0.08
JN0203	20	195.	1.44	-0.04	0.934	212.	1.43	-0.13	0.934	17.	-0.00	-0.09
JN0204	4	284.	3.43	-0.75	0.936	223.	3.01	-0.86	0.926	19.	-0.42	-0.11
JN0204	26	197.	3.06	-0.05	0.975	207.	2.50	0.08	0.979	9.	-0.56	0.13
JN0204	48	211.	2.65	0.18	0.967	203.	2.25	0.25	0.961	-8.	-0.41	0.07
JN0204	55	*****	*****	0.967	201.	2.00	0.23	0.924	*****	*****	*****	
EH0202	4	173.	1.39	-0.17	0.884	166.	0.99	-0.06	0.749	-7.	-0.40	0.11
EH0202	25	159.	1.33	-0.02	0.923	152.	1.03	-0.00	0.894	-7.	-0.30	0.02
EH0202	46	161.	1.25	0.16	0.860	142.	1.11	-0.09	0.729	-19.	-0.13	-0.24
EH0202	55	*****	*****	0.860	116.	0.93	0.04	0.871	*****	*****	*****	
EH0203	4	175.	1.48	-0.09	0.866	165.	0.97	-0.19	0.723	-10.	-0.51	-0.09
EH0203	22	168.	1.34	-0.00	0.871	158.	1.13	0.07	0.901	-10.	-0.21	0.08
EH0203	40	163.	1.36	0.11	0.884	149.	1.11	0.29	0.845	-14.	-0.25	0.18
EH0501	4	178.	0.94	-0.30	0.776	184.	0.66	0.09	0.249	6.	-0.28	0.39
EH0501	22	180.	0.98	0.01	0.935	161.	0.53	-0.09	0.468	-19.	-0.45	-0.11
EH0501	39	194.	0.85	0.13	0.791	147.	0.88	0.14	0.759	-46.	0.02	0.00
EH0501	45	*****	*****	0.791	151.	0.96	0.15	0.668	*****	*****	*****	
EH0701	4	188.	1.20	-0.20	0.622	179.	0.65	0.00	0.724	-1.	-0.55	0.21
EH0701	19	177.	1.32	-0.02	0.707	164.	0.79	-0.04	0.586	-14.	-0.53	-0.02
EH0701	35	166.	1.22	-0.01	0.694	153.	0.82	-0.05	0.668	-14.	-0.40	-0.04
EH0701	40	*****	*****	0.694	147.	0.68	-0.02	0.577	*****	*****	*****	
EH0901	4	183.	0.86	-0.32	0.370	168.	0.77	-0.21	0.479	5.	-0.09	0.10
EH0901	19	161.	0.64	0.01	0.498	145.	0.53	0.07	0.415	-16.	-0.11	0.05
EH0901	35	137.	0.46	-0.03	0.657	132.	0.45	-0.03	0.217	-5.	0.00	0.00
EE0301	4	173.	0.71	0.00	0.626	166.	0.82	0.09	0.795	-8.	0.12	0.09
EE0301	21	162.	0.47	0.11	0.594	172.	0.41	0.11	0.515	10.	-0.06	-0.00
UB0201	4	172.	1.48	0.06	0.904	166.	1.52	0.33	0.875	-7.	0.04	0.27
UB0201	13	171.	1.35	0.13	0.694	174.	1.45	0.20	0.926	3.	0.09	0.07

(Sheet 9 of 12)

Table 9D

TEST 4

70,000 cfs, ±1.5 ft Ocean Tide Amplitude

STATION	DEPTH FT	TEST <<<<<<		TEST >>>>>>		TEST <<<<<<		TEST >>>>>>		>>PLAN-MINUS-BASE<<		
		PHASE DEG	AMP FPS	MEAN FPS	R-SQUARE	PHASE DEG	AMP FPS	MEAN FPS	R-SQUARE	PHASE DEG	AMP FPS	
C80001	4	224.	1.50	-0.91	0.810	219.	1.31	-0.41	0.848	-5.	-0.19	0.51
C80001	18	209.	1.56	-0.38	0.947	196.	1.18	-0.21	0.878	-13.	-0.38	0.17
C80001	32	172.	1.52	-0.28	0.829	154.	1.22	-0.03	0.857	-18.	-0.38	0.25
C80002	4	231.	1.49	-0.41	0.976	221.	1.22	-0.43	0.978	-10.	-0.27	-0.02
C80002	20	212.	1.61	0.05	0.962	219.	1.37	0.09	0.944	7.	-0.24	0.04
C80002	35	212.	1.53	0.27	0.957	215.	1.48	0.31	0.945	3.	-0.13	0.03
C80002	54	202.	1.64	0.29	0.965	211.	1.48	0.27	0.942	9.	-0.16	-0.02
C80002	71	209.	1.23	0.34	0.929	200.	1.18	0.27	0.923	-9.	-0.05	-0.07
C80004	4	245.	1.51	-0.59	0.920	229.	1.47	-0.60	0.895	-17.	-0.04	-0.01
C80004	16	235.	1.58	-0.04	0.975	219.	1.58	-0.02	0.954	-16.	0.01	0.02
C80004	28	219.	1.27	0.11	0.955	199.	1.18	0.16	0.957	-21.	-0.09	0.05
C80006	4	230.	2.30	-0.55	0.963	220.	2.06	-0.42	0.959	-10.	-0.23	0.13
C80006	15	210.	1.70	-0.08	0.883	213.	1.63	0.04	0.960	2.	-0.07	0.11
C80008	4	217.	2.43	-0.14	0.785	220.	2.85	-0.14	0.955	3.	-0.37	-0.00
C80008	24	204.	2.24	-0.21	0.918	209.	1.88	-0.05	0.934	5.	-0.35	0.16
C80008	43	198.	2.02	0.15	0.854	204.	1.52	0.05	0.930	5.	-0.50	-0.10
C80009	4	207.	3.46	-0.25	0.977	202.	3.22	-0.23	0.944	-5.	-0.24	0.02
C80009	16	193.	3.07	0.06	0.964	195.	3.08	0.04	0.976	2.	-0.07	-0.01
C80101	4	241.	1.64	-0.02	0.896	255.	1.06	-0.03	0.614	15.	-0.59	-0.01
C80101	13	243.	1.22	-0.04	0.871	237.	1.03	-0.03	0.899	-5.	-0.19	0.02
C80103	4	270.	1.18	-0.33	0.922	263.	0.97	-0.31	0.795	-8.	-0.22	0.03
C80103	14	267.	1.06	-0.26	0.998	254.	0.97	-0.24	0.789	-13.	-0.08	0.02
C80103	24	229.	1.10	0.05	0.886	230.	0.95	-0.01	0.843	0.	-0.15	-0.06
C80105	4	257.	1.45	-0.09	0.967	254.	1.22	-0.01	0.960	-2.	-0.23	0.07
C80105	20	242.	1.33	0.30	0.945	232.	1.17	0.30	0.932	-10.	-0.21	0.00
C80105	37	228.	1.32	0.29	0.918	214.	1.07	0.24	0.921	-14.	-0.25	-0.05
C80107	4	247.	1.56	-0.11	0.963	251.	1.36	0.03	0.954	3.	-0.20	0.14
C80107	15	248.	1.56	0.08	0.953	249.	1.42	0.13	0.943	1.	-0.13	0.05
C80107	27	234.	1.27	0.31	0.942	234.	0.71	0.21	0.848	-0.	-0.56	-0.10
C80109	4	253.	1.23	-0.21	0.977	251.	1.20	-0.14	0.918	-3.	-0.03	0.07
C80109	39	243.	1.19	0.10	0.848	239.	1.15	0.14	0.762	-4.	-0.04	0.04
C80109	75	199.	0.90	0.11	0.835	194.	0.67	-0.08	0.801	-4.	-0.23	-0.19

(Continued)

(Sheet 10 of 12)

Table 9D (Continued)

STATION	DEPTH FT	>>>>> BASE TEST <<<<<			>>>>> PLAN TEST <<<<<			>>PLAN-MINUS-BASE<<				
		PHASE DEG	AMP FPS	MEAN FPS	R-SQUARE	PHASE DEG	AMP FPS	MEAN FPS	R-SQUARE	PHASE (DEG)	AMP (FPS)	MEAN (FPS)
CBO110	4	244.	1.78	-0.27	0.939	245.	1.60	-0.36	0.881	1.	-0.18	-0.09
CBO110	15	238.	1.44	-0.04	0.978	234.	1.53	-0.07	0.957	-4.	0.10	-0.03
AC0002	4	211.	0.63	-0.25	0.830	210.	0.55	-0.08	0.783	-1.	-0.08	0.17
AC0002	27	213.	0.70	0.18	0.928	212.	0.49	0.16	0.740	-1.	-0.20	-0.02
AC0002	49	191.	0.51	0.12	0.841	201.	0.47	0.17	0.661	10.	-0.03	0.05
AC0002	54	*****	*****	*****	0.841	203.	0.54	0.14	0.802	*****	*****	*****
TS0003	4	216.	1.96	-0.40	0.949	197.	1.18	-0.16	0.699	-19.	-0.78	0.24
TS0003	26	221.	1.83	0.27	0.957	205.	1.30	0.26	0.887	-16.	-0.53	-0.01
TS0003	46	226.	1.60	0.19	0.900	212.	1.28	0.51	0.911	-13.	-0.32	0.32
TS0003	51	*****	*****	*****	0.900	213.	1.28	0.47	0.915	*****	*****	*****
TS0005	4	227.	1.79	-0.89	0.969	229.	1.77	-0.64	0.848	2.	-0.02	0.25
TS0005	27	214.	1.50	0.00	0.921	205.	1.57	0.79	0.847	-9.	0.07	0.79
TS0005	50	216.	0.94	1.58	0.640	223.	1.03	1.29	0.851	7.	0.09	-0.28
TS0005	55	*****	*****	*****	0.640	216.	1.01	1.18	0.818	*****	*****	*****
YS0001	4	234.	2.37	0.00	0.911	227.	2.18	0.09	0.848	-6.	-0.20	0.09
YS0001	25	229.	2.23	0.77	0.964	220.	2.14	0.75	0.943	-9.	-0.09	-0.02
YS0001	45	227.	1.76	0.79	0.815	220.	1.76	0.76	0.381	-7.	0.00	-0.04
JG0101	4	183.	2.31	-0.24	0.943	176.	2.04	-0.21	0.878	-7.	-0.27	0.04
JG0101	11	183.	1.90	-0.16	0.940	179.	1.74	-0.17	0.935	-3.	-0.17	-0.01
JG0102	4	207.	2.79	-0.51	0.970	200.	2.36	-0.40	0.695	-7.	-0.44	0.12
JG0102	26	206.	2.40	-0.25	0.936	195.	2.01	-0.21	0.943	-11.	-0.39	0.04
JG0102	48	191.	2.42	-0.27	0.918	174.	1.99	-0.29	0.862	-17.	-0.42	-0.02
JG0103	4	205.	2.29	-0.45	0.968	210.	2.22	-0.63	0.923	5.	-0.07	-0.17
JG0103	22	207.	1.94	-0.24	0.934	199.	1.94	-0.21	0.943	-8.	-0.00	0.02
JG0103	44	190.	1.86	0.20	0.880	181.	1.95	0.31	0.874	-9.	0.09	0.11
JG0103	66	172.	1.63	0.44	0.667	164.	1.69	0.60	0.793	-8.	0.06	0.16
JG0103	83	156.	1.08	0.36	0.673	141.	1.02	0.58	0.630	-15.	-0.06	0.22
JG0311	4	258.	1.69	-0.33	0.972	243.	1.60	-0.03	0.860	-15.	-0.30	0.30
JG0311	11	259.	1.47	-0.16	0.932	252.	1.45	-0.05	0.939	-7.	-0.63	0.12
JG0302	4	250.	2.15	-0.18	0.968	242.	1.47	0.15	0.955	-8.	-0.69	0.32
JG0302	16	249.	1.77	0.09	0.958	245.	1.13	0.02	0.886	-4.	-0.64	-0.07
JG0302	27	251.	1.22	0.08	0.922	248.	0.60	-0.09	0.635	-3.	-0.62	-0.17

(Continued)

(Sheet 11 of 12)

Table 9D (Concluded)

STATION	DEPTH FT	>>>>> BASE TEST <<<<<				>>>>> PLAN TEST <<<<<				>>PLAN-MINUS-BASE<<			
		PHASE DEG	AMP FPS	MEAN FPS	R-SQUARE	PHASE (DEG)	AMP (FPS)	MEAN (FPS)	R-SQUARE	PHASE (DEG)	AMP (FPS)	MEAN (FPS)	R-SQUARE
JGB321	4	256.	2.16	-0.33	0.976	254.	1.91	-0.24	0.900	-2.	-0.25	0.89	
JN0202	4	186.	1.36	-0.12	0.865	199.	0.77	-0.06	0.876	13.	-0.59	0.07	
JN0202	12	199.	0.99	0.05	0.963	190.	0.56	0.02	0.880	-9.	-0.43	-0.03	
JN0203	4	245.	1.82	-0.69	0.919	229.	1.29	-0.48	0.947	-15.	-0.53	0.21	
JN0203	20	214.	1.17	-0.12	0.915	208.	0.96	-0.11	0.738	-5.	-0.21	0.00	
JN0204	4	234.	2.02	-0.69	0.942	223.	1.61	-0.58	0.939	-11.	-0.49	0.11	
JN0204	26	214.	1.94	0.09	0.981	207.	1.75	0.07	0.957	-7.	-0.19	-0.03	
JN0204	48	197.	1.38	0.65	0.938	198.	1.63	0.98	0.944	1.	0.24	0.32	
JN0204	55	*****	*****	*****	0.938	196.	1.44	0.98	0.892	*****	*****	*****	
EH0202	4	190.	1.00	-0.22	0.780	174.	0.78	-0.19	0.701	-16.	-0.23	0.03	
EH0202	25	175.	1.05	0.15	0.812	170.	0.54	0.17	0.625	-4.	-0.59	0.02	
EH0202	46	143.	0.72	0.18	0.621	96.	0.11	0.06	0.116	-46.	-0.61	-0.12	
EH0202	55	*****	*****	*****	0.621	101.	0.08	0.02	0.047	*****	*****	*****	
EH0203	4	182.	0.81	-0.22	0.906	159.	0.80	-0.26	0.817	-23.	-0.02	-0.04	
EH0203	22	171.	0.92	0.11	0.773	161.	0.71	0.04	0.811	-18.	-0.21	-0.08	
EH0203	40	127.	0.81	0.20	0.723	101.	0.17	0.02	0.178	-26.	-0.64	-0.17	
EH0501	4	169.	0.38	-0.08	0.579	198.	0.18	-0.09	0.443	29.	-0.20	-0.02	
EH0501	22	185.	0.35	0.07	0.441	211.	0.06	0.03	0.060	25.	-0.29	-0.04	
EH0501	39	186.	0.31	0.00	0.393	170.	0.51	-0.09	0.769	-16.	-0.20	-0.10	
EH0501	45	*****	*****	*****	0.393	150.	0.47	-0.05	0.816	*****	*****	*****	
EH0701	4	202.	0.36	-0.11	0.568	194.	0.19	-0.03	0.335	-8.	-0.17	0.08	
EH0701	19	167.	0.77	-0.16	0.741	165.	0.69	-0.16	0.813	-2.	-0.08	-0.00	
EH0701	35	146.	0.73	-0.04	0.780	152.	0.36	0.06	0.593	7.	-0.37	0.10	
EH0701	40	*****	*****	*****	0.780	142.	0.29	0.06	0.457	*****	*****	*****	
EH0901	4	177.	0.40	-0.13	0.583	194.	0.27	-0.15	0.334	17.	-0.13	-0.02	
EH0901	19	157.	0.39	-0.02	0.589	167.	0.29	-0.07	0.298	10.	-0.11	-0.06	
EH0901	35	173.	0.17	0.00	0.445	157.	0.32	0.05	0.255	-16.	0.15	0.05	
EE0301	4	182.	0.61	0.15	0.754	129.	0.36	0.02	0.495	-7.	-0.25	-0.13	
EE0301	21	147.	0.29	0.22	0.532	175.	0.14	0.09	0.196	28.	-0.14	-0.13	
LB0201	4	172.	1.31	0.08	0.919	171.	1.05	0.10	0.885	-1.	-0.26	0.02	
LB0201	13	165.	1.14	0.09	0.938	158.	0.81	0.07	0.900	-7.	-0.33	-0.02	

(Sheet 12 of 12)

Table 10A

Steady-State Velocity Tests
Plan-Minus-Base Phase, Amplitude, and Mean Differences

STATION DEPTH FT	TEST. 1			TEST. 2			TEST. 3			TEST. 4		
	PHASE DIFF DEG	AMP.		MEAN DIFF FPS	AMP.		MEAN DIFF FPS	AMP.		MEAN DIFF FPS	AMP.	
		DIFF	DEG		DIFF	DEG		DIFF	DEG		DIFF	DEG
E80001	4	3.	-0.10	0.27	18.	-0.05	0.12	5.	-0.27	0.26	-5.	-0.19
E80001	18	1.	-0.12	-0.03	7.	0.09	-0.03	2.	-0.16	0.15	-13.	-0.38
E80001	32	-4.	-0.05	0.09	10.	0.13	-0.12	-3.	-0.26	0.11	-18.	-0.30
E80002	4	8.	-0.17	0.02	18.	0.03	0.69	11.	-0.06	0.15	-10.	-0.27
E80002	20	9.	-0.57	-0.26	9.	-0.18	0.14	11.	0.11	-0.05	7.	-0.24
E80002	35	-2.	-0.05	0.09	10.	-0.24	0.13	6.	0.10	-0.02	3.	-0.13
E80002	54	-4.	-0.27	0.08	12.	-0.19	-0.02	5.	0.08	-0.12	9.	-0.16
E80002	71	-5.	-0.59	-0.10	-4.	-0.23	-0.02	7.	0.29	-0.01	-9.	-0.05
E80004	4	3.	0.17	-0.01	8.	0.32	-0.38	5.	-0.43	-0.04	-17.	-0.04
E80004	16	6.	0.06	0.02	6.	0.32	-0.10	6.	-0.13	-0.14	-16.	0.01
E80004	28	3.	-0.05	0.08	12.	0.46	0.02	-10.	0.14	-0.05	-21.	-0.09
E80006	4	5.	0.56	-0.74	3.	0.13	-0.18	7.	-0.27	-0.07	-10.	-0.23
E80006	15	4.	0.47	-0.16	11.	-0.13	0.01	1.	0.05	0.12	2.	-0.07
E80008	4	0.	2.53	-0.53	14.	0.17	-0.18	15.	0.14	0.03	3.	-0.37
E80008	24	0.	2.17	-0.22	16.	-0.03	-0.29	9.	0.20	0.05	5.	-0.35
E80008	43	2.	1.70	-0.14	-2.	0.07	0.05	10.	-0.23	0.12	5.	-0.50
E80009	4	2.	-0.35	-0.03	-10.	-0.36	0.05	6.	-0.67	0.29	-5.	-0.24
E80009	16	4.	-0.71	0.10	-5.	-0.15	-0.03	8.	-0.34	0.16	2.	-0.07
E80101	4	4.	-0.11	-0.03	12.	-0.39	-0.03	-6.	-0.18	0.06	15.	-0.59
E80101	13	11.	0.25	-0.08	6.	-0.21	0.07	-4.	-0.08	-0.03	-5.	-0.19
E80103	4	-5.	-0.07	-0.03	-2.	-0.37	0.08	-5.	-0.22	-0.02	-8.	-0.22
E80103	14	3.	-0.07	-0.02	-9.	-0.39	0.09	-5.	-0.19	-0.03	-13.	-0.08
E80103	24	11.	-0.30	0.02	-2.	-0.46	-0.05	-11.	-0.43	0.02	0.	-0.15
E80105	4	-10.	-0.11	0.03	4.	-0.52	0.33	16.	-0.30	-0.01	-2.	-0.23
E80105	20	3.	-0.07	-0.04	-9.	-0.47	0.58	12.	-0.01	-0.04	-10.	-0.21
E80105	37	6.	0.28	0.22	-5.	-0.25	-0.03	4.	-0.39	-0.06	-14.	-0.25
E80107	4	-11.	-0.11	0.04	16.	-0.22	0.07	10.	0.24	-0.04	3.	-0.20
E80107	15	-13.	-0.29	0.06	1.	-0.04	0.00	3.	0.13	-0.14	1.	-0.13
E80107	27	-9.	-0.12	-0.01	11.	-0.30	-0.03	10.	-0.07	0.03	-8.	-0.56
E80109	4	9.	0.05	-0.09	-2.	0.15	-0.07	18.	0.23	-0.54	-3.	-0.03
E80109	39	7.	0.02	-0.22	9.	-0.06	-0.12	3.	-0.02	0.05	-4.	-0.04
E80109	75	12.	-0.24	-0.19	20.	0.03	0.08	14.	-0.30	0.06	-4.	-0.23

(Continued)

Table 10A (Continued)

STATION	DEPTH	TEST 1			TEST 2			TEST 3			TEST 4		
		PHASE	AMP.	MEAN									
	FT	DIFF	DIFF	FPS									
EBO110	4	-0.13	-0.11	-5.	-0.14	-0.10	12.	-0.30	-0.02	1.	-0.18	-0.09	
EBO110	15	4.	0.00	-0.04	-5.	0.04	-0.15	9.	-0.16	0.06	-4.	0.10	-0.03
AC0002	4	1.	-0.20	-0.00	11.	-0.19	-0.04	6.	-0.40	0.28	-1.	-0.08	0.17
AC0002	27	19.	-0.24	0.09	-10.	-0.18	-0.01	4.	-0.24	-0.01	-1.	-0.20	-0.02
AC0002	49	-10.	-0.06	-0.04	7.	-0.02	-0.07	8.	0.13	-0.01	10.	-0.03	0.05
AC0002	54	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
TS0003	4	-10.	-0.43	0.02	-15.	-0.18	0.09	-11.	-0.22	0.16	-19.	-0.78	0.24
TS0003	26	-13.	-0.31	0.00	-14.	0.02	-0.08	-10.	-0.36	0.18	-16.	-0.53	-0.01
TS0003	46	-13.	-0.06	0.18	-6.	0.25	0.06	-6.	0.25	0.10	-13.	-0.32	0.32
TS0003	51	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
TS0005	4	-4.	-0.12	-0.01	10.	-0.19	0.11	5.	-0.29	0.08	2.	-0.02	0.25
TS0005	27	-10.	-0.35	0.07	15.	0.35	0.25	-1.	-0.17	-0.15	-9.	0.07	0.79
TS0005	50	-13.	0.17	-0.20	17.	0.13	-0.04	8.	0.49	-0.29	7.	0.09	-0.28
TS0005	55	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
YS0001	4	-2.	-0.41	-0.16	6.	-0.31	-0.09	13.	0.12	0.22	-6.	-0.20	0.09
YS0001	25	-10.	-0.22	-0.16	15.	0.51	0.67	17.	-0.14	0.14	-9.	-0.09	-0.02
YS0001	45	-9.	0.07	-0.01	12.	-0.25	-0.25	10.	0.12	0.25	-7.	0.00	-0.04
JG0101	4	-11.	0.24	-0.36	6.	-0.20	-0.07	7.	-0.31	0.10	-7.	-0.27	0.04
JG0101	11	-19.	-0.22	-0.13	-5.	-0.26	-0.09	12.	-0.11	-0.09	-3.	-0.17	-0.01
JG0102	4	6.	-0.83	0.14	4.	0.10	-0.25	-1.	-0.67	0.20	-7.	-0.44	0.12
JG0102	26	2.	-0.30	0.03	-2.	-0.06	-0.09	0.	-0.44	0.08	-11.	-0.39	0.04
JG0102	48	6.	-0.95	0.15	5.	0.07	0.12	-2.	-0.16	-0.02	-17.	-0.42	-0.02
JG0103	4	9.	-0.00	-0.07	11.	0.15	-0.15	7.	-0.32	-0.13	5.	-0.07	-0.17
JG0103	22	6.	0.19	0.14	4.	-0.16	0.16	8.	-0.46	0.08	-8.	-0.00	0.02
JG0103	44	12.	-0.01	-0.11	10.	0.28	0.05	17.	0.23	0.12	-9.	0.09	0.11
JG0103	66	5.	0.80	0.15	-4.	0.06	0.03	4.	0.37	0.08	-8.	0.06	0.16
JG0103	83	-64.	1.00	0.46	8.	-0.10	-0.10	9.	0.21	-0.07	-15.	-0.06	0.22
JG0311	4	5.	0.11	0.10	6.	0.36	-0.05	-6.	-0.20	0.26	-15.	-0.30	0.30
JG0311	11	7.	-0.04	0.02	17.	0.37	0.04	-5.	0.08	0.00	-7.	-0.03	0.12
JG0302	4	8.	0.39	-0.12	-4.	-0.03	0.07	10.	-0.37	0.12	-8.	-0.69	0.32
JG0302	16	8.	0.34	-0.00	-13.	-0.19	-0.32	8.	-0.22	0.06	-4.	-0.64	-0.07
JG0302	27	9.	0.29	-0.07	-6.	0.13	-0.10	5.	-0.07	-0.07	-3.	-0.62	-0.17

(Continued)

(Sheet 2 of 6)

Table 10A (Concluded)

STATION	DEPTH	TEST 1			TEST 2			TEST 3			TEST 4		
		PHASE DIFF DEG	AMP. DIFF FPS	MEAN MEAN									
JG0321	4	-7.	-0.46	0.04	-1.	0.09	-0.02	5.	-0.19	0.04	-2.	-0.25	0.09
JN0202	4	-9.	0.21	-0.15	-9.	0.06	-0.11	3.	-0.26	0.09	13.	-0.59	0.07
JN0202	12	-3.	-0.48	0.06	4.	-0.00	-0.04	-0.	-0.13	-0.00	-9.	-0.43	-0.03
JN0203	4	10.	-0.17	0.00	-4.	-0.18	0.07	3.	0.09	-0.08	-15.	-0.53	0.21
JN0203	20	-2.	-0.04	-0.08	10.	0.04	-0.06	17.	-0.00	-0.09	-5.	-0.21	0.00
JN0204	4	14.	0.26	-0.63	18.	0.29	-0.04	19.	-0.42	-0.11	-11.	-0.40	0.11
JN0204	26	6.	-0.17	0.05	-1.	-0.29	0.01	9.	-0.56	0.13	-7.	-0.19	-0.03
JN0204	48	-2.	0.04	0.21	14.	0.05	0.09	-8.	-0.41	0.07	1.	0.24	0.32
JN0204	55	**	**	**	**	**	**	**	**	**	**	**	**
EH0202	4	5.	-0.12	0.07	-12.	-0.13	0.04	-7.	-0.40	0.11	-16.	-0.23	0.03
EH0202	25	-2.	-0.05	0.12	9.	0.42	0.10	-7.	-0.30	0.02	-4.	-0.50	0.02
EH0202	46	10.	-0.99	-0.20	19.	0.47	-0.03	-19.	-0.13	-0.24	-46.	-0.61	-0.12
EH0202	55	**	**	**	**	**	**	**	**	**	**	**	**
EH0203	4	5.	-0.02	-0.02	-0.	-0.34	0.20	-10.	-0.51	-0.09	-23.	-0.02	-0.04
EH0203	22	7.	-0.09	0.16	10.	-0.03	-0.02	-10.	-0.21	0.08	-10.	-0.21	-0.08
EH0203	49	11.	-0.85	-0.15	-13.	0.09	-0.08	-14.	-0.25	0.18	-26.	-0.64	-0.17
EH0501	-10.	-0.14	0.01	23.	0.11	-0.02	6.	-0.28	0.39	29.	-0.28	-0.02	**
EH0501	-2.	0.07	-0.15	-4.	-0.11	0.06	-15.	-0.45	-0.11	25.	-0.29	-0.04	**
EH0501	39	-25.	0.12	-0.22	-57.	-0.28	0.13	-46.	0.02	0.00	-16.	0.20	-0.10
EH0501	45	**	**	**	**	**	**	**	**	**	**	**	**
EH0701	4	-10.	-0.45	0.22	-5.	-0.09	0.16	-1.	-0.55	0.21	-8.	-0.17	0.08
EH0701	19	-11.	-0.08	0.03	-11.	-0.08	0.12	-14.	-0.53	-0.02	-2.	-0.08	-0.00
EH0701	35	-12.	-0.26	0.09	-5.	0.33	-0.15	-14.	-0.40	-0.04	7.	-0.37	0.10
EH0701	46	**	**	**	**	**	**	**	**	**	**	**	**
EH0901	4	11.	-0.24	0.26	6.	-0.01	0.04	5.	-0.08	0.10	17.	-0.13	-0.02
EH0901	19	-17.	-0.24	0.12	-5.	-0.08	-0.15	-16.	-0.11	0.05	18.	-0.11	-0.06
EH0901	35	13.	-0.15	0.00	66.	0.00	0.02	-5.	0.00	0.00	-16.	0.15	0.05
EE0701	4	-1.	0.23	0.04	13.	-0.15	-0.04	-8.	0.12	0.09	-3.	-0.25	-0.13
EE0701	21	4.	-0.15	-0.02	-10.	-0.62	-0.13	10.	-0.06	-0.00	28.	-0.14	-0.13
EE0201	4	-10.	0.12	-0.18	10.	-0.92	-0.05	-7.	0.04	0.27	-1.	-0.26	0.02
EE0201	13	-8.	0.21	-0.06	3.	-0.15	-0.10	3.	0.09	0.07	-7.	-0.33	-0.02

(Sheet 3 of 6)

Table 10B

Steady-State Velocity Tests

Plan-Minus-Base Phase Differences: Summary Statistics

CLASS INTERVAL	*** TEST 1 ***		*** TEST 2 ***		*** TEST 3 ***		*** TEST 4 ***		*** OVERALL *** FREQ. RELATIVE FREQ.
	FREQ.	RELATIVE FREQ.	FREQ.	RELATIVE FREQ.	FREQ.	RELATIVE FREQ.	FREQ.	RELATIVE FREQ.	
GREATER THAN 30 DEG	0	0.000	0	0.000	0	0.000	0	0.000	0
25 < DIFF < 30 DEG	0	0.000	0	0.000	0	0.000	3	0.034	3
20 < DIFF < 25 DEG	0	0.000	1	0.011	0	0.000	0	0.000	1
15 < DIFF < 20 DEG	1	0.011	10	0.115	7	0.080	1	0.011	19
10 < DIFF < 15 DEG	8	0.092	16	0.184	10	0.114	3	0.034	37
5 < DIFF < 10 DEG	21	0.241	17	0.195	28	0.318	8	0.091	74
0 < DIFF < 5 DEG	21	0.241	7	0.080	11	0.125	10	0.114	49
-5 < DIFF < 0 DEG	11	0.126	19	0.218	8	0.091	17	0.193	55
-10 < DIFF < -5 DEG	12	0.138	9	0.103	14	0.159	23	0.251	58
-15 < DIFF < -10 DEG	10	0.115	7	0.080	6	0.068	8	0.091	31
-20 < DIFF < -15 DEG	2	0.023	0	0.000	3	0.034	11	0.125	16
-25 < DIFF < -20 DEG	1	0.011	0	0.000	0	0.000	2	0.023	3
-30 < DIFF < -25 DEG	0	0.000	0	0.000	0	0.000	1	0.011	1
LESS THAN -30 DEG	0	0.000	1	0.011	1	0.011	1	0.011	3
NUMBER IN SAMPLE	87		88		88		88		350
MEAN DIFFERENCE (DEG)	0.19		2.11		-4.68		2.11		0.18
STANDARD DEVIATION (DEG)	8.77		11.37		10.49		11.32		10.92

(Sheet 4 of 6)

Table 10C

Steady-State Velocity Tests

Plan-Minus-Base Amplitude Differences: Summary Statistics

CLASS INTERVAL	*** TEST 1 ***		*** TEST 2 ***		*** TEST 3 ***		*** TEST 4 ***		*** OVERALL ***	
	FREQ.	RELATIVE FREQ.	FREQ.	RELATIVE FREQ.						
GREATER THAN 0.8 FPS	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
0.7 < DIFF < 0.8 FPS	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
0.6 < DIFF < 0.7 FPS	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
0.5 < DIFF < 0.6 FPS	1	0.012	1	0.011	0	0.000	0	0.000	2	0.026
0.4 < DIFF < 0.5 FPS	1	0.012	3	0.034	1	0.011	0	0.000	5	0.014
0.3 < DIFF < 0.4 FPS	2	0.024	6	0.069	1	0.011	0	0.000	9	0.026
0.2 < DIFF < 0.3 FPS	8	0.096	3	0.034	6	0.068	2	0.023	19	0.055
0.1 < DIFF < 0.2 FPS	6	0.072	9	0.162	10	0.114	1	0.011	26	0.075
0.0 < DIFF < 0.1 FPS	7	0.084	14	0.159	8	0.091	7	0.000	36	0.104
-0.1 < DIFF < 0.0 FPS	16	0.193	15	0.170	9	0.102	18	0.000	58	0.167
-0.2 < DIFF < -0.1 FPS	16	0.193	17	0.193	14	0.159	14	0.000	61	0.176
-0.3 < DIFF < -0.2 FPS	10	0.120	9	0.102	16	0.182	21	0.000	56	0.161
-0.4 < DIFF < -0.3 FPS	4	0.048	7	0.080	8	0.091	8	0.000	27	0.078
-0.5 < DIFF < -0.4 FPS	5	0.060	2	0.023	9	0.102	4	0.000	20	0.053
-0.6 < DIFF < -0.5 FPS	2	0.024	1	0.011	4	0.045	7	0.000	14	0.040
-0.7 < DIFF < -0.6 FPS	0	0.000	1	0.011	2	0.023	5	0.000	8	0.023
-0.8 < DIFF < -0.7 FPS	1	0.012	0	0.000	0	0.000	1	0.000	2	0.006
LESS THAN -0.9 FPS	4	0.048	0	0.000	0	0.000	0	0.000	4	0.012
NUMBER IN SHUFFLE	93		36						33	
MEAN DIFFERENCE (FPS)	-0.12		-0.14						-0.12	
STANDARD DEVIATION (FPS)	0.33		0.24						0.21	

(Sheet 5 of 6)

Table 10D

Steady-State Velocity Tests

Plan-Minus-Base Mean Velocity Differences: Summary Statistics

CLASS INTERVAL	*** TEST 1 ***		*** TEST 2 ***		*** TEST 3 ***		*** TEST 4 ***		*** OVERALL ***
	FREQ.	RELATIVE FREQ.							
GREATER THAN 0.8 FPS	0	0.000	0	0.000	0	0.000	0	0.000	0
0.7 < DIFF. < 0.8 FPS	0	0.000	0	0.000	0	0.000	1	0.011	1
0.6 < DIFF. < 0.7 FPS	0	0.000	2	0.023	0	0.000	0	0.038	2
0.5 < DIFF. < 0.6 FPS	0	0.000	1	0.011	0	0.000	1	0.011	2
0.4 < DIFF. < 0.5 FPS	1	0.011	0	0.000	0	0.000	0	0.000	1
0.3 < DIFF. < 0.4 FPS	0	0.000	1	0.011	1	0.011	4	0.045	6
0.2 < DIFF. < 0.3 FPS	5	0.057	1	0.011	8	0.091	5	0.357	19
0.1 < DIFF. < 0.2 FPS	9	0.102	11	0.125	17	0.193	11	0.125	48
0.0 < DIFF. < 0.1 FPS	27	0.307	23	0.261	25	0.284	27	0.307	102
-0.1 < DIFF. < 0.0 FPS	22	0.250	33	0.375	27	0.307	30	0.341	112
-0.2 < DIFF. < -0.1 FPS	15	0.170	12	0.136	7	0.080	8	0.091	42
-0.3 < DIFF. < -0.2 FPS	5	0.057	3	0.034	2	0.023	1	0.011	11
-0.4 < DIFF. < -0.3 FPS	1	0.011	1	0.011	0	0.000	0	0.000	2
-0.5 < DIFF. < -0.4 FPS	0	0.000	0	0.000	0	0.000	0	0.000	0
-0.6 < DIFF. < -0.5 FPS	1	0.011	0	0.000	1	0.011	9	0.000	2
-0.7 < DIFF. < -0.6 FPS	1	0.011	0	0.000	0	0.000	0	0.000	1
-0.8 < DIFF. < -0.7 FPS	1	0.011	0	0.000	0	0.000	0	0.000	1
LESS. THAN -0.8 FPS	0	0.000	0	0.000	0	0.000	0	0.000	0
NUMBER IN SAMPLE	86		88		88		88		352
MEAN DIFFERENCE (FPS)	-0.03		0.01		0.04		0.04		0.02
STANDARD DEVIATION (FPS)	0.18		0.17		0.14		0.15		0.16

(sheet 6 of 6)

Table 11A
TEST 1
Maximum Flood and Ebb Velocities

STATION	DEPTH	>>>>>> MODEL DATA <<<<<<<				>>>>>> HARMONIC ANALYSIS <<<<<<			
		**** BASE TEST ****		**** PLAN TEST ****		**** BASE TEST ****		**** PLAN TEST ****	
		MAX FLOOD	MAX EBB	MAX FLOOD	MAX EBB	MAX FLOOD	MAX EBB	MAX FLOOD	MAX EBB
VELOCITY	VELOCITY	VELOCITY	VELOCITY	VELOCITY	VELOCITY	VELOCITY	VELOCITY	VELOCITY	VELOCITY
FT	FPS	FT	FPS	FT	FPS	FT	FPS	FT	FPS
CB0001	4	1.97	4.25	2.13	3.88	1.72	3.95	1.89	3.58
CB0001	18	2.12	3.32	2.23	3.39	1.95	3.31	1.79	3.22
CB0001	32	1.75	2.23	1.68	2.23	1.45	2.54	1.49	2.40
CB0002	4	1.48	3.21	1.33	2.89	1.38	2.82	1.23	2.63
CB0002	20	2.94	2.87	1.63	2.84	2.19	2.82	1.37	2.51
CB0002	35	3.31	2.55	3.11	2.35	2.89	2.21	2.92	2.07
CB0002	54	3.25	2.55	2.89	2.22	3.01	2.42	2.82	2.07
CB0002	71	2.42	2.18	1.95	1.63	2.59	1.99	1.90	1.51
CB0004	4	1.39	2.97	1.58	3.13	1.41	2.65	1.57	2.84
CB0004	16	2.39	2.60	2.32	2.87	2.07	2.65	2.14	2.69
CB0004	28	2.51	1.77	2.58	1.87	2.42	1.84	2.44	1.71
CB0006	4	3.97	3.27	3.45	4.68	3.28	3.49	3.09	4.79
CB0006	15	2.60	2.66	3.03	3.45	2.45	2.80	2.76	3.43
CB0008	4	0.66	1.19	2.69	4.28	0.76	1.17	2.75	4.23
CB0008	24	0.80	0.93	2.63	3.42	0.79	0.94	2.73	3.33
CB0008	43	0.66	0.60	1.99	2.72	0.66	0.55	2.22	2.39
CB0009	4	4.53	4.67	3.91	5.11	4.47	5.26	4.10	4.94
CB0009	16	4.54	4.77	3.64	4.17	4.33	4.96	3.72	4.15
CB0101	4	1.77	2.94	1.65	2.87	1.87	2.76	1.73	2.68
CB0101	13	1.25	1.90	1.75	2.09	1.43	1.76	1.60	2.09
CB0103	4	1.55	2.53	1.64	1.94	1.56	2.15	1.47	2.10
CB0103	14	1.54	2.23	1.61	2.27	1.70	2.17	1.61	2.12
CB0103	24	1.58	1.96	1.21	1.74	1.49	1.80	1.20	1.48
CB0105	4	1.91	2.07	1.99	2.05	1.94	2.10	1.86	2.06
CB0105	20	2.52	1.87	2.36	1.68	2.32	1.80	2.22	1.77
CB0105	37	1.78	0.97	2.02	1.04	1.48	0.97	1.97	1.03
CB0107	4	2.40	2.67	2.20	2.39	1.98	2.72	1.91	2.57
CB0107	15	2.47	2.20	2.24	2.11	2.42	2.29	2.20	1.94
CB0107	27	2.17	1.22	1.89	1.40	1.99	1.17	1.86	1.07
CB0109	4	1.77	2.60	1.57	2.72	1.50	2.74	1.47	2.88
CB0109	39	2.28	1.38	2.14	1.64	2.24	1.20	2.05	1.44
CB0109	75	1.71	0.43	1.26	0.40	1.60	0.33	1.16	0.28

(Continued)

(Sheet 1 of 12)

Table 11A (Continued)

STATION	DEPTH FT	>>>>>> MODEL DATA <<<<<<						>>>>>> HARMONIC ANALYSIS <<<<<<					
		*** BASE TEST ***		*** PLAN TEST ***		*** TEST ***		*** PLATE TEST ***		MAX FLOOD	MAX EBB	MAX FLOOD	MAX EBB
		MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS	MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS	MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS	MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS	MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS	MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS
CB0110	4	2.30	2.08	2.18	2.97	2.12	3.12	1.87	3.11	1.65	2.34	1.65	2.38
CB0110	15	1.56	2.36	1.70	2.47	1.69	1.94	0.24	1.94	0.03	0.24	0.03	1.75
AC0002	4	0.42	2.02	0.18	1.80	0.24	0.95	1.21	0.95	1.06	0.75	1.06	0.62
AC0002	27	1.24	1.05	1.00	0.75	1.40	0.70	1.40	0.70	1.31	0.68	1.23	0.64
AC0002	49	1.36	0.77	1.38	0.84	1.32	0.68	1.32	0.68	1.23	0.68	1.23	0.64
AL0002	54	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
TS0003	4	2.52	4.10	2.15	3.35	2.49	3.44	3.10	2.50	2.08	2.99	2.08	2.99
TS0003	26	3.52	2.43	2.90	2.12	2.12	2.79	2.50	2.79	2.19	2.50	2.19	2.50
TS0003	45	3.33	2.46	3.48	2.26	3.09	2.26	2.26	2.26	2.26	2.26	2.26	2.26
TS0003	51	*****	*****	3.22	2.26	*****	*****	*****	*****	*****	*****	*****	*****
TS0005	4	2.10	4.26	1.91	4.58	1.97	4.19	2.10	2.10	1.94	4.08	1.94	4.08
TS0005	27	2.23	2.68	1.94	2.61	2.18	2.63	2.61	2.63	1.98	2.21	1.98	2.21
TS0005	50	3.55	0.23	3.51	0.43	3.69	0.48	3.69	0.48	3.66	0.11	3.66	0.11
TS0005	55	*****	*****	3.26	0.00	*****	*****	*****	*****	3.24	0.31	3.24	0.31
YS0001	4	4.13	3.49	3.81	3.23	3.71	3.56	3.96	3.71	3.56	3.14	3.57	3.30
YS0001	25	4.51	2.31	4.10	2.02	3.96	2.59	3.96	3.96	3.96	3.57	3.96	3.57
YS0001	45	3.24	1.64	3.33	1.67	3.48	1.63	3.48	3.48	3.48	3.57	3.48	3.57
JG0101	4	2.26	2.37	2.12	3.25	2.56	2.84	2.56	2.56	2.56	2.45	2.56	2.45
JG0101	11	2.30	3.20	1.99	2.91	2.53	2.98	2.53	2.53	2.53	2.19	2.53	2.19
JG0102	4	3.10	4.80	2.53	3.82	3.57	4.83	3.82	3.57	3.82	2.88	3.82	2.88
JG0102	26	2.98	4.03	2.80	3.60	3.05	4.05	3.60	3.05	3.60	2.78	3.60	2.78
JG0102	48	2.84	3.84	2.26	2.97	3.17	3.68	2.97	3.17	3.68	2.38	3.68	2.38
JG0103	4	2.67	4.64	2.58	4.19	2.93	4.33	2.58	2.93	2.86	4.48	2.86	4.48
JG0103	22	2.24	3.70	2.68	3.55	2.61	3.72	2.68	3.55	2.61	2.94	2.68	3.72
JG0103	44	2.83	3.83	2.84	3.39	3.21	3.29	3.21	3.39	3.21	3.09	3.29	3.09
JG0103	66	2.34	1.63	2.58	2.97	1.86	2.81	2.58	2.97	1.86	1.96	2.81	1.96
JG0103	83	0.34	0.45	1.78	2.09	0.13	0.16	0.13	2.09	0.13	0.70	0.16	0.70
JG0311	4	1.75	2.68	2.13	2.60	1.94	2.77	2.13	2.60	1.94	2.78	2.13	2.78
JG0311	11	1.68	2.45	1.81	2.46	1.80	2.58	1.81	2.46	1.80	2.53	1.81	2.53
JG0302	4	1.86	2.31	2.24	2.67	1.99	2.45	2.24	2.67	1.99	2.56	2.24	2.56
JG0302	16	1.51	2.21	1.96	2.45	1.71	2.24	1.96	2.45	1.71	2.59	2.24	2.59
JG0302	27	1.35	1.67	1.71	2.14	1.45	1.80	1.67	2.14	1.45	1.66	1.67	1.66

(Continued)

(Sheet 2 of 12)

Table 11A (Concluded)

STATION	DEPTH FT	>>>>> MODEL DATA <<<<<<						>>>>>> HARMONIC ANALYSIS <<<<<<					
		*** BASE TEST ***			*** PLAN TEST ***			*** BASE TEST ***			*** PLAN TEST ***		
		MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS	MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS	MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS	MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS	MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS	MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS
JG0321	4	2.01	3.25	1.77	2.72	2.25	3.28	1.83	2.78	1.83	2.78	1.83	2.78
JN0202	4	1.04	1.13	1.06	1.55	1.05	1.04	1.11	1.41	0.77	0.77	0.77	0.78
JN0202	12	1.13	1.46	0.66	0.88	1.19	1.32	1.23	2.23	1.23	1.23	1.23	2.23
JN0203	4	1.33	2.33	1.19	2.02	1.39	2.41	1.49	1.10	1.10	1.10	1.10	1.53
JN0203	20	1.27	1.52	1.01	1.62	1.21	1.49	1.14	1.76	1.14	1.76	1.14	4.03
JN0204	4	2.64	3.05	1.92	4.28	2.13	3.14	2.64	2.62	2.64	2.62	2.64	2.42
JN0204	26	2.58	2.58	2.47	2.53	2.74	2.64	2.62	2.62	2.62	2.62	2.62	2.42
JN0204	48	2.55	1.81	2.91	1.48	2.60	1.77	2.85	1.61	2.85	1.61	2.85	1.61
JN0204	55	*****	*****	2.72	1.12	*****	*****	*****	*****	2.86	2.86	2.86	0.96
EH0202	4	1.32	1.98	1.27	1.51	1.01	1.64	0.95	1.46	0.95	1.46	0.95	1.46
EH0202	25	1.21	1.14	1.24	1.17	1.03	1.16	1.10	0.99	1.10	0.99	1.10	0.99
EH0202	45	1.65	1.18	0.45	0.56	1.40	1.15	0.21	0.36	0.21	0.36	0.21	0.36
EH0202	55	*****	*****	0.65	0.42	*****	*****	*****	*****	0.29	0.29	0.29	0.23
EH0203	4	1.28	1.88	0.98	1.68	0.86	1.36	0.83	1.36	0.83	1.36	0.83	1.36
EH0203	22	1.41	1.38	1.35	1.14	1.09	1.07	1.17	0.82	1.17	0.82	1.17	0.82
EH0203	40	1.98	1.21	1.08	0.45	1.64	0.95	0.64	0.25	0.64	0.25	0.64	0.25
EH0501	4	0.52	1.07	0.61	0.84	0.56	0.86	0.43	0.71	0.43	0.71	0.43	0.71
EH0501	22	0.75	0.91	0.57	0.75	0.68	0.52	0.60	0.74	0.60	0.74	0.60	0.74
EH0501	39	0.68	0.75	0.52	0.97	0.63	0.47	0.53	0.81	0.53	0.81	0.53	0.81
EH0501	45	*****	*****	0.66	0.75	*****	*****	*****	*****	0.61	0.63	0.61	0.63
EH0701	4	0.86	1.61	0.78	0.78	0.90	1.27	0.66	0.60	0.66	0.60	0.66	0.60
EH0701	19	0.75	1.78	0.75	1.71	0.70	0.88	0.65	0.78	0.65	0.78	0.65	0.78
EH0701	35	0.73	1.75	0.72	1.12	0.61	1.02	0.64	0.66	0.64	0.66	0.64	0.66
EH0701	40	*****	*****	0.62	0.62	*****	*****	*****	*****	0.63	0.63	0.63	0.63
EH0901	4	0.49	2.20	0.61	1.55	0.56	1.74	0.57	1.24	0.57	1.24	0.57	1.24
EH0901	19	0.36	1.26	0.44	0.35	0.31	0.57	0.19	0.21	0.19	0.21	0.19	0.21
EH0901	35	0.26	0.59	0.18	0.18	0.21	0.25	0.06	0.09	0.06	0.09	0.06	0.09
EE0301	4	1.13	0.93	1.25	1.40	0.78	0.79	1.05	0.99	1.05	0.99	1.05	0.99
EE0301	21	0.69	0.42	0.36	0.42	0.37	0.28	0.28	0.14	0.28	0.14	0.28	0.14
WB0201	4	2.24	1.51	2.55	1.74	1.99	1.56	1.93	1.86	1.93	1.86	1.93	1.86
WB0201	13	1.93	1.14	2.08	1.31	1.63	1.19	1.78	1.45	1.78	1.45	1.78	1.45

(Sheet 3 of 12)

Table 11B
TEST 2
Maximum Flood and Ebb Velocities

STATION	DEPTH FT	>>>>>> MODEL DATA <<<<<<						>>>>>> HARMONIC ANALYSIS <<<<<<					
		BASE TEST ****		PLAN TEST ****		TEST ****		BASE TEST ****		PLAN TEST ****		TEST ****	
		MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS
CB0001	4	0.64	2.84	0.97	2.69	0.87	2.61	0.93	2.44	0.96	1.49	0.96	1.49
CB0001	18	1.17	1.44	1.29	1.51	0.89	1.37	1.24	1.24	1.24	1.54	1.24	1.54
CB0001	32	1.57	1.24	1.51	1.57	1.24	1.29	1.24	1.24	1.24	1.49	1.24	1.49
CB0002	4	0.65	2.15	1.08	1.82	0.61	2.14	1.33	1.33	1.33	1.49	1.33	1.49
CB0002	22	1.67	1.42	1.95	1.14	1.69	1.41	1.64	1.64	1.64	1.79	1.64	1.79
CB0002	35	1.77	1.29	1.68	1.08	1.70	1.24	1.58	1.58	1.58	1.87	1.58	1.87
CB0002	54	1.89	1.29	1.85	1.08	1.84	1.32	1.63	1.63	1.63	1.75	1.63	1.75
CB0002	71	1.64	1.29	1.52	1.18	1.58	1.09	1.33	1.33	1.33	0.87	1.33	0.87
CB0004	4	0.82	2.18	0.79	2.85	0.90	1.85	0.84	0.84	0.84	2.56	0.84	2.56
CB0004	16	1.71	1.41	1.84	1.64	1.35	1.30	1.57	1.57	1.57	1.72	1.57	1.72
CB0004	28	1.21	1.18	1.81	1.45	1.12	1.00	1.61	1.61	1.61	1.45	1.61	1.45
CB0006	4	1.39	2.58	1.13	2.93	1.12	2.55	1.07	1.07	1.07	2.85	1.07	2.85
CB0006	15	1.92	1.89	1.65	1.70	1.62	1.86	1.51	1.51	1.51	1.72	1.51	1.72
CB0008	4	1.64	3.07	1.59	3.28	1.41	2.80	1.39	1.39	1.39	3.15	1.39	3.15
CB0008	24	2.17	2.05	1.78	2.20	2.11	1.91	1.79	1.79	1.79	2.17	1.79	2.17
CB0008	43	1.83	1.37	1.82	1.32	1.54	0.98	1.65	1.65	1.65	0.99	1.65	0.99
CB0009	4	3.56	4.55	3.39	4.05	3.52	4.27	3.22	3.22	3.22	3.86	3.22	3.86
CB0009	16	3.18	2.97	2.97	2.72	2.88	2.79	2.71	2.71	2.71	2.67	2.71	2.67
CB0101	4	1.40	2.27	1.20	2.06	1.44	2.27	1.02	1.02	1.02	1.91	1.02	1.91
CB0101	13	1.07	1.59	1.12	1.48	1.08	1.40	0.94	0.94	0.94	1.12	0.94	1.12
CB0103	4	0.73	1.56	0.55	1.32	0.73	1.52	0.44	0.44	0.44	1.07	0.44	1.07
CB0103	14	0.80	1.49	0.55	1.32	0.74	1.56	0.44	0.44	0.44	1.07	0.44	1.07
CB0103	24	0.77	1.23	0.52	1.06	0.92	1.06	0.41	0.41	0.41	0.65	0.41	0.65
CE0105	4	1.23	2.16	1.13	1.20	1.30	2.10	1.11	1.11	1.11	1.25	1.11	1.25
CB0105	20	1.39	1.78	1.65	0.63	1.45	1.77	1.57	1.57	1.57	0.72	1.57	0.72
CB0105	37	1.68	0.94	1.37	0.69	1.59	0.82	1.21	1.21	1.21	0.60	1.21	0.60
CB0107	4	1.31	1.68	1.09	1.42	1.14	1.73	0.99	0.99	0.99	1.44	0.99	1.44
CB0107	15	1.40	1.37	1.32	1.19	1.27	1.29	1.23	1.23	1.23	1.24	1.23	1.24
CB0107	27	1.27	1.04	0.92	0.69	1.03	0.76	0.76	0.76	0.76	0.48	0.76	0.48
CB0109	4	0.72	1.48	0.91	1.48	0.59	1.44	0.67	0.67	0.67	1.67	0.67	1.67
CB0109	39	1.88	1.65	1.57	1.54	1.84	1.27	1.67	1.67	1.67	1.33	1.67	1.33
CB0109	75	1.14	1.31	1.20	1.29	0.98	1.19	1.01	1.01	1.01	1.14	1.01	1.14

(Continued)

(Sheet 4 of 12)

Table 11B (Continued)

STATION	DEPTH FT	>>>>>> MODEL DATA <<<<<<						>>>>>> HARMONIC ANALYSIS <<<<<<					
		**** BASE TEST ****			**** PLAN TEST ****			**** BASE TEST ****			**** PLAN TEST ****		
		MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS
CB0110	4	1.70	1.70	1.37	1.77	1.31	1.98	1.07	1.07	1.07	1.93		
CB0110	15	1.57	1.17	1.40	1.35	1.18	1.14	1.07	1.07	1.07	1.33		
AC0002	4	0.38	0.93	0.11	0.95	0.36	0.75	0.14	0.14	0.14	0.60		
AC0002	27	0.90	0.38	0.85	0.29	0.76	0.47	0.57	0.57	0.57	0.30		
AC0002	49	0.87	0.38	0.95	0.39	0.77	0.34	0.68	0.68	0.68	0.39		
AC0002	54	*****	*****	0.78	0.29	*****	*****	0.51	0.51	0.51	0.32		
TS0003	4	1.46	2.06	1.51	1.75	1.11	2.09	1.02	1.02	1.02	1.81		
TS0003	26	1.99	1.59	2.22	1.58	2.05	1.31	1.99	1.99	1.99	1.41		
TS0003	46	1.89	1.33	2.16	1.44	1.88	1.01	2.19	2.19	2.19	1.19		
TS0003	51	*****	*****	2.09	1.27	*****	*****	2.00	2.00	2.00	1.02		
TS0005	4	0.00	2.82	0.00	2.00	0.29	2.29	0.21	0.21	0.21	1.98		
TS0005	27	1.24	1.49	1.61	1.77	1.04	1.19	1.64	1.64	1.64	1.29		
TS0005	50	2.79	0.53	2.75	1.22	2.82	0.19	2.91	2.91	2.91	0.37		
TS0005	55	*****	*****	2.78	0.95	*****	*****	2.82	2.82	2.82	0.36		
YS0001	4	2.40	1.66	2.13	1.63	1.57	2.03	1.17	1.17	1.17	1.81		
YS0001	25	2.47	1.60	3.09	1.41	2.09	1.52	3.27	3.27	3.27	1.36		
YS0001	45	3.15	1.29	2.72	1.11	3.34	1.21	2.84	2.84	2.84	1.21		
JG0101	4	1.82	3.39	1.56	2.94	1.93	3.06	1.56	1.56	1.56	2.93		
JG0101	11	1.72	2.33	1.28	2.11	1.67	2.27	1.31	1.31	1.31	2.10		
JG0102	4	1.99	3.13	2.02	3.62	2.03	3.22	1.89	1.89	1.89	3.57		
JG0102	26	2.11	2.23	2.09	2.67	1.98	2.05	1.83	1.83	1.83	2.09		
JG0102	48	1.43	1.08	1.17	1.58	1.20	0.95	1.39	1.39	1.39	0.89		
JG0103	4	1.61	3.23	1.68	3.57	1.92	3.08	1.92	1.92	1.92	3.38		
JG0103	22	1.45	2.40	1.74	2.26	1.81	2.10	1.80	1.80	1.80	1.78		
JG0103	44	1.55	1.29	1.68	1.55	1.51	0.93	1.64	1.64	1.64	1.16		
JG0103	66	1.77	1.45	1.87	1.35	1.88	0.89	1.97	1.97	1.97	0.92		
JG0103	83	1.20	0.84	1.15	0.86	1.39	0.47	1.18	1.18	1.18	0.47		
JG0311	4	1.13	1.78	1.59	2.08	1.17	1.68	1.49	1.49	1.49	2.09		
JG0311	11	0.81	1.52	1.37	1.68	0.90	1.37	1.31	1.31	1.31	1.69		
JG0302	4	1.50	2.11	1.44	2.28	1.48	2.08	1.53	1.53	1.53	1.97		
JG0302	16	1.51	1.54	1.19	1.44	1.32	1.53	1.12	1.12	1.12	1.36		
JG0302	27	0.67	0.92	0.43	1.25	0.40	0.43	0.43	0.43	0.43	1.06		

(Continued)

(Sheet 5 of 12)

Table 11B (Concluded)

STATION	DEPTH	F.T.	>>>>>>> MODEL DATE <<<<<<<				>>>>>>> HARMONIC ANALYSIS <<<<<<<			
			*** BASE TEST ***		*** PLAN TEST ***		*** BASE TEST ***		*** PLAN TEST ***	
			MAX FLOOD	MAX EBB	MAX FLOOD	MAX EBB	MAX FLOOD	MAX EBB	MAX FLOOD	MAX EBB
VELOCITY	VELOCITY	VELOCITY	VELOCITY	VELOCITY	VELOCITY	VELOCITY	VELOCITY	VELOCITY	VELOCITY	VELOCITY
FPS	FPS	FPS	FPS	FPS	FPS	FPS	FPS	FPS	FPS	FPS
JG0321	4	1.23	1.97	1.31	2.10	1.30	1.99	1.37	2.10	2.10
JN0202	4	0.87	1.09	0.81	1.19	0.82	0.87	0.77	1.04	1.04
JN0202	12	0.75	0.78	0.62	0.62	0.55	0.59	0.60	0.63	0.63
JN0203	4	0.95	1.98	0.76	1.93	0.82	2.01	0.71	1.76	1.76
JN0203	26	0.76	1.07	0.76	1.53	0.81	0.92	0.78	1.02	1.02
JN0204	4	1.09	2.60	1.32	3.17	1.22	2.56	1.47	2.88	2.88
JN0204	26	1.77	1.55	1.80	1.80	1.54	1.84	1.84	1.51	1.51
JN0204	48	3.00	0.59	3.43	0.33	2.70	0.44	2.04	0.40	0.40
JN0204	55	*****	*****	3.39	0.37	*****	*****	2.77	0.34	0.34
EH0202	4	1.44	1.24	1.22	1.04	0.63	1.33	0.75	1.16	1.16
EH0202	25	0.69	0.13	1.04	0.51	0.46	0.18	0.98	0.50	0.50
EH0202	46	0.25	0.31	0.37	0.52	0.10	0.13	0.54	0.62	0.62
EH0202	55	*****	*****	0.56	0.39	*****	*****	0.24	0.36	0.36
EH0203	4	0.73	1.27	0.51	0.87	0.62	1.28	0.47	0.74	0.74
EH0203	22	1.13	0.42	1.09	0.34	0.89	0.32	0.85	0.32	0.32
EH0203	40	0.35	0.22	0.34	0.60	0.15	0.10	0.16	0.28	0.28
EH0501	4	0.36	0.33	0.61	0.58	0.25	0.27	0.34	0.40	0.40
EH0501	22	0.55	0.52	0.55	0.41	0.29	0.40	0.25	0.23	0.23
EH0501	39	0.45	1.01	0.34	0.75	0.39	0.89	0.24	0.48	0.48
EH0501	45	*****	*****	0.51	0.62	*****	*****	0.31	0.55	0.55
EH0701	4	0.00	0.93	0.22	0.56	0.11	0.69	0.17	0.42	0.42
EH0701	19	0.45	1.10	0.42	0.93	0.43	0.91	0.47	0.71	0.71
EH0701	35	0.49	1.00	0.66	1.27	0.53	0.46	0.71	0.94	0.94
EH0701	40	*****	*****	0.55	1.04	*****	*****	0.63	0.90	0.90
EH0901	4	0.28	1.02	0.29	1.05	0.34	0.93	0.36	0.89	0.89
EH0901	19	0.72	0.28	0.72	0.58	0.46	0.27	0.22	0.35	0.35
EH0901	35	0.00	0.14	0.22	2.11	0.01	0.03	0.04	0.02	0.02
EE0301	4	0.90	0.50	0.60	0.47	0.72	0.51	0.53	0.39	0.39
EE0301	21	0.97	0.93	0.00	0.51	0.81	0.86	0.06	0.37	0.37
UB0201	4	1.35	1.13	1.18	0.95	1.16	0.93	1.08	0.96	0.96
UB0201	13	0.92	0.73	0.74	0.92	0.75	0.75	0.64	0.70	0.70

(Sheet 6 of 12)

Table 11C

TEST 3

Maximum Flood and Ebb Velocities

STATION	DEPTH FT	>>>>>> MODEL DATA <<<<<<						>>>>>> HARMONIC ANALYSIS <<<<<<					
		*** BASE TEST ***		*** PLAN TEST ***		*** HARMONIC ANALYSIS ***		*** PLAN TEST ***		*** HARMONIC ANALYSIS ***		*** PLAN TEST ***	
		MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS	MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS	MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS	MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS	MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS	MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS
CB0001	4	1.83	3.68	1.93	2.82	1.72	3.58	1.72	3.05	1.72	3.05	1.72	3.05
CB0001	18	2.05	2.63	2.33	2.51	1.82	2.91	1.82	2.69	1.82	2.69	1.82	2.69
CB0001	32	1.86	2.51	1.40	2.24	1.55	2.53	1.40	2.15	1.40	2.15	1.40	2.15
CB0002	4	2.70	3.12	2.91	2.85	2.10	2.97	2.19	2.77	2.19	2.77	2.19	2.77
CB0002	20	2.70	2.24	3.01	2.45	2.54	2.36	2.60	2.51	2.60	2.51	2.60	2.51
CB0002	35	2.88	2.28	3.08	2.45	2.73	2.20	2.81	2.33	2.81	2.33	2.81	2.33
CB0002	54	2.88	2.39	3.11	2.52	2.81	2.13	2.70	2.25	2.70	2.25	2.70	2.25
CB0002	71	2.27	1.74	2.55	2.45	2.09	1.82	2.27	2.12	2.27	2.12	2.27	2.12
CB0004	4	2.73	3.43	2.26	3.37	2.55	3.03	2.08	2.64	2.08	2.64	2.08	2.64
CB0004	16	2.79	2.61	2.48	2.79	2.50	2.43	2.23	2.44	2.23	2.44	2.23	2.44
CB0004	28	1.81	1.99	1.98	2.20	1.74	1.69	1.83	1.88	1.83	1.88	1.83	1.88
CB0006	4	3.47	4.04	3.35	3.55	3.25	4.20	2.91	4.01	2.91	4.01	2.91	4.01
CB0006	15	2.59	3.09	2.77	2.97	2.43	3.23	2.61	3.16	2.61	3.16	2.61	3.16
CB0008	4	2.84	4.29	3.09	4.12	2.82	3.98	3.00	4.08	3.00	4.08	3.00	4.08
CB0008	24	3.10	3.65	3.09	4.16	2.88	3.44	3.13	3.59	3.13	3.59	3.13	3.59
CB0008	43	2.61	3.13	2.71	2.88	2.35	3.01	2.73	2.66	2.73	2.66	2.73	2.66
CB0009	4	4.43	5.69	4.39	4.77	4.71	5.52	4.33	4.56	4.33	4.56	4.33	4.56
CB0009	16	4.37	4.74	4.07	4.77	4.48	4.73	4.39	4.23	4.39	4.23	4.39	4.23
CB0101	4	1.64	2.07	1.52	2.05	1.63	2.07	1.52	1.83	1.52	1.83	1.52	1.83
CB0101	13	1.30	1.94	1.31	2.01	1.45	1.76	1.34	1.71	1.34	1.71	1.34	1.71
CB0103	4	2.02	2.24	1.75	2.36	1.88	2.41	1.64	2.21	1.64	2.21	1.64	2.21
CB0103	14	1.92	2.12	1.78	2.02	1.96	2.13	1.74	1.96	1.74	1.96	1.74	1.96
CB0103	24	1.70	1.95	1.51	1.47	1.76	1.95	1.35	1.50	1.95	1.35	1.50	1.50
CB0105	4	2.26	2.16	2.06	1.80	2.11	2.11	1.80	1.82	1.80	1.82	1.80	1.82
CB0105	20	2.15	1.58	2.02	1.80	2.01	1.63	1.95	1.65	1.63	1.65	1.63	1.65
CB0105	37	2.10	1.39	1.67	1.16	1.97	1.21	1.52	0.88	1.21	1.52	0.88	0.88
CB0107	4	2.25	2.32	2.39	2.81	2.09	2.35	2.29	2.63	2.35	2.63	2.29	2.63
CB0107	15	2.52	2.03	2.36	2.22	2.42	1.86	2.41	2.13	2.41	2.13	2.41	2.13
CB0107	27	2.16	1.42	2.10	1.55	2.09	1.49	2.05	1.40	2.05	1.40	2.05	1.40
CB0109	4	1.91	2.00	1.65	3.35	1.69	2.20	1.38	2.97	1.38	2.97	1.38	2.97
CB0109	39	2.07	1.54	2.00	1.43	2.14	1.33	2.17	1.26	2.14	1.26	2.17	1.26
CB0109	75	1.54	0.00	1.42	0.00	1.33	0.23	1.09	0.58	1.09	0.58	1.09	0.58

(Continued)

(Sheet 7 of 12)

Table 11C (Continued)

STATION	DEPTH	>>>>>> MODEL DATA <<<<<<						>>>>>> HARMONIC ANALYSIS <<<<<<					
		*** BASE TEST ***			*** PLAN TEST ***			*** BASE TEST ***			*** PLAN TEST ***		
		MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS	MAX EBB VELOCITY FPS	MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS	MAX EBB VELOCITY FPS	MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS	MAX EBB VELOCITY FPS	MAX FLOOD VELOCITY FPS	MAX EBB VELOCITY FPS	MAX EBB VELOCITY FPS
CB0110	4	2.06	3.00	2.19	2.64	2.18	3.14	1.86	2.67	1.87	1.98	2.67	2.44
CB0110	15	2.00	2.45	1.96	2.19	1.94	2.18	0.18	0.29	1.94	0.18	1.26	1.26
AC0002	4	0.62	1.87	0.25	1.44	0.29	1.44	1.11	1.36	1.02	1.02	0.79	0.79
AC0002	27	1.36	1.20	1.25	0.81	1.36	1.31	1.43	0.72	0.72	0.72	0.86	0.86
AC0002	49	1.27	0.79	1.37	0.98	1.31	1.31	1.43	0.72	0.72	0.72	0.86	0.86
AC0002	54	*****	*****	1.25	0.75	*****	*****	1.26	1.26	1.26	1.26	0.80	0.80
TS0003	4	2.81	3.64	2.81	3.18	2.54	3.42	2.48	2.48	2.48	2.48	3.05	3.05
TS0003	26	3.49	2.58	3.32	2.50	3.14	2.64	2.97	2.97	2.97	2.97	2.09	2.09
TS0003	46	2.74	2.52	3.38	2.84	2.8?	2.19	3.22	3.22	3.22	3.22	2.33	2.33
TS0003	51	*****	*****	3.25	2.67	*****	*****	2.91	2.91	2.91	2.91	2.28	2.28
TS0005	4	2.20	3.78	2.02	3.49	2.15	3.59	1.95	1.95	1.95	1.95	3.22	3.22
TS0005	27	2.72	2.62	2.21	2.50	2.39	2.53	2.07	2.07	2.07	2.07	2.50	2.50
TS0005	50	2.85	0.00	3.01	0.49	2.78	0.35	2.98	2.98	2.98	2.98	0.42	0.42
TS0005	55	*****	*****	2.54	0.43	*****	*****	2.62	2.62	2.62	2.62	0.10	0.10
YS0001	4	4.26	2.76	4.65	2.98	3.63	3.18	3.96	3.96	3.96	3.96	3.09	3.09
YS0001	25	4.57	2.15	4.21	2.41	3.79	2.68	3.80	3.80	3.80	3.80	2.40	2.40
YS0001	45	3.55	1.83	4.08	1.88	3.14	2.08	3.51	3.51	3.51	3.51	1.94	1.94
JG0101	4	2.38	3.14	2.02	2.60	2.70	2.74	2.48	2.48	2.48	2.48	2.33	2.33
JG0101	11	2.02	2.62	1.96	2.47	2.37	2.19	2.17	2.17	2.17	2.17	2.17	2.17
JG0102	4	2.94	4.24	2.63	3.10	3.16	4.19	2.69	2.69	2.69	2.69	3.32	3.32
JG0102	26	2.51	3.99	2.32	3.19	2.85	3.67	2.50	2.50	2.50	2.50	3.15	3.15
JG0102	48	2.67	3.43	2.60	3.16	2.92	3.31	2.76	2.76	2.76	2.76	3.15	3.15
JG0103	4	2.93	3.59	2.64	3.49	3.10	3.64	2.65	2.65	2.65	2.65	3.46	3.46
JG0103	22	2.68	2.87	2.33	2.64	2.83	3.07	2.46	2.46	2.46	2.46	2.53	2.53
JG0103	44	2.20	2.36	2.39	2.81	2.43	2.45	2.78	2.78	2.78	2.78	2.57	2.57
JG0103	66	2.23	2.68	2.57	3.21	2.66	1.67	3.11	3.11	3.11	3.11	2.16	2.16
JG0103	83	2.23	1.33	2.29	1.48	1.63	0.52	1.78	1.78	1.78	1.78	0.81	0.81
JG0311	4	1.63	3.14	1.86	2.34	1.78	2.85	1.84	1.84	1.84	1.84	2.39	2.39
JG0311	11	1.49	2.15	1.89	2.12	1.69	2.15	1.77	1.77	1.77	1.77	2.23	2.23
JG0302	4	2.09	2.72	1.84	2.30	2.25	2.83	2.00	2.00	2.00	2.00	2.34	2.34
JG0302	16	2.02	2.31	1.75	2.10	2.06	2.36	1.89	1.89	1.89	1.89	2.08	2.08
JG0302	27	1.71	1.52	1.45	2.04	1.71	1.77	1.64	1.64	1.64	1.64	1.84	1.84

(Continued)

(Sheet 8 of 12)

Table 11C (Concluded)

STATION	DEPTH FT	>>>>>> MODEL DATA <<<<<<						>>>>>> HARMONIC ANALYSIS <<<<<<					
		**** BASE TEST ****			**** PLAN TEST ****			**** BASE TEST ****			**** PLAN TEST ****		
		MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS
JG0321	4	1.84	2.34	1.61	2.47	1.90	2.65	1.74	2.42				
JN0202	4	1.39	1.93	1.30	1.54	1.58	1.69	1.41	1.35				
JN0202	12	1.27	1.39	1.30	1.30	1.42	1.32	1.29	1.20				
JN0203	4	1.36	2.12	1.18	2.20	1.23	2.03	1.24	2.19				
JN0203	20	1.33	1.43	1.18	1.58	1.40	1.48	1.30	1.57				
JN0204	4	3.06	4.12	2.54	4.03	2.67	4.18	2.15	3.86				
JN0204	26	2.77	2.91	2.29	2.45	3.01	3.11	2.58	2.42				
JN0204	48	2.81	2.39	2.26	2.20	2.84	2.47	2.50	2.00				
JN0204	55	*****	2.05	2.08	*****	*****	*****	2.23	1.77				
EH0202	4	1.33	1.78	1.24	1.17	1.22	1.56	0.93	1.05				
EH0202	25	1.39	1.55	1.09	1.18	1.31	1.35	1.03	1.04				
EH0202	46	1.68	1.29	1.24	1.49	1.40	1.09	1.02	1.20				
EH0202	55	*****	1.18	0.96	*****	*****	*****	0.97	0.89				
EH0203	4	1.46	1.58	0.84	1.42	1.39	1.57	0.78	1.16				
EH0203	22	1.46	1.46	1.26	1.36	1.34	1.35	1.20	1.06				
EH0203	40	1.62	1.49	1.52	0.98	1.47	1.26	1.41	0.82				
EH0501	4	0.74	1.62	1.04	1.10	0.64	1.24	0.76	0.57				
EH0501	22	1.01	1.04	0.52	0.88	0.99	0.97	0.43	0.62				
EH0501	39	1.10	0.89	1.07	0.88	0.99	0.72	1.01	0.74				
EH0501	45	*****	1.13	0.91	*****	*****	*****	1.11	0.82				
EH0701	4	0.97	2.36	0.64	0.82	0.99	1.40	0.65	0.64				
EH0701	19	1.13	1.87	0.64	1.50	1.30	1.34	0.75	0.84				
EH0701	35	1.30	2.03	0.83	1.41	1.21	1.23	0.77	0.87				
EH0701	40	*****	0.73	1.35	*****	*****	*****	0.67	0.70				
EH0901	4	0.76	1.83	0.76	1.37	0.54	1.17	0.56	0.98				
EH0901	19	0.57	1.36	0.79	1.04	0.65	0.63	0.60	0.46				
EH0901	35	0.45	0.77	0.52	1.00	0.43	0.49	0.43	0.49				
EF0301	4	0.97	1.13	1.18	0.91	0.71	0.70	0.92	0.73				
EL0301	21	0.55	0.55	0.62	0.38	0.58	0.36	0.52	0.30				
UB0201	4	1.94	1.27	1.87	1.42	1.54	1.41	1.85	1.18				
UB0201	13	1.87	1.30	1.63	1.16	1.49	1.22	1.65	1.25				

(Sheet 9 of 12)

Table 11D

TEST 4

Maximum Flood and Ebb Velocities

STATION	DEPTH FT	>>>>> MODEL DATA <<<<<				>>>>> HARMONIC ANALYSIS <<<<<			
		**** BASE TEST ****		**** PLAN TEST ****		**** BASE TEST ****		**** PLAN TEST ****	
		MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS						
CB0001	4	0.35	2.76	0.96	1.89	0.58	2.41	0.90	1.71
CB0001	18	1.21	1.77	1.09	1.46	1.18	1.93	0.97	1.39
CB0001	32	1.68	1.48	1.49	1.25	1.24	1.80	1.19	1.25
CB0002	4	1.13	1.94	0.72	1.71	1.08	1.90	0.79	1.65
CB0002	28	1.78	1.75	1.67	1.31	1.66	1.55	1.46	1.28
CB0002	35	1.90	1.36	2.00	1.05	1.81	1.26	1.71	1.09
CB0002	54	1.97	1.39	1.87	1.28	1.93	1.36	1.75	1.21
CB0002	71	1.78	0.97	1.64	0.92	1.56	2.89	1.45	0.90
CB0004	4	0.79	2.30	0.75	2.40	0.92	2.10	0.88	2.07
CB0004	16	1.59	1.68	1.67	1.83	1.54	1.62	1.56	1.60
CB0004	28	1.41	1.32	1.41	1.04	1.39	1.16	1.34	1.02
CB0006	4	1.86	3.04	1.79	2.66	1.75	2.85	1.64	2.48
CB0006	15	1.89	1.64	1.75	1.65	1.62	1.78	1.67	1.60
CB0008	4	1.99	3.18	1.83	2.30	2.29	2.56	1.91	2.19
CB0008	24	1.99	2.49	1.83	2.05	2.02	2.45	1.83	1.94
CB0008	43	2.19	2.35	1.67	1.64	2.17	1.88	1.57	1.47
CB0009	4	3.35	3.47	3.36	3.36	3.21	3.71	2.98	3.45
CB0009	16	3.35	3.03	3.22	3.02	3.12	3.01	3.04	2.96
CB0101	4	1.58	2.00	1.27	1.27	1.62	1.66	1.03	1.09
CB0101	13	1.10	1.58	0.96	1.31	1.18	1.26	1.00	1.06
CB0103	4	0.81	1.65	0.75	1.51	0.85	1.52	0.66	1.27
CB0103	14	0.94	1.49	1.00	1.34	0.80	1.32	0.74	1.21
CB0103	24	1.16	1.16	0.96	1.16	1.15	1.05	0.94	0.96
CB0105	4	1.37	1.61	1.29	1.23	1.36	1.53	1.21	1.24
CB0105	20	1.67	1.18	1.51	0.97	1.68	1.09	1.47	0.88
CB0105	37	1.51	1.11	1.26	0.97	1.61	1.03	1.31	0.84
CB0107	4	1.47	1.84	1.39	1.39	1.45	1.67	1.39	1.33
CB0107	15	1.63	1.43	1.70	1.18	1.64	1.47	1.56	1.29
CB0107	27	1.50	1.06	0.83	0.69	1.58	0.96	0.92	0.51
CB0109	4	0.99	1.40	1.18	1.31	1.02	1.43	1.06	1.33
CB0109	39	1.46	1.15	1.44	1.13	1.29	1.09	1.28	1.01
CB0109	75	1.27	0.72	0.74	0.78	1.00	0.79	0.59	0.75

(Continued)

(Sheet 10 of 12)

Table 11D (Continued)

STATION	DEPTH FT	>>>>>> MODEL DATA <<<<<<						>>>>>> HARMONIC ANALYSIS <<<<<<					
		**** BASE TEST ****			**** PLAN TEST ****			**** BASE TEST ****			**** PLAN TEST ****		
		MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX FLOOD VELOCITY. FPS	MAX EBB VELOCITY. FPS	MAX EBB VELOCITY. FPS
CB0110	4	1.51	2.09	1.58	1.78	1.51	1.51	2.06	1.24	1.96			
CB0110	15	1.42	1.58	1.38	1.71	1.40	1.48	1.47	1.47	1.68			
AC0002	4	0.29	0.94	0.59	0.76	0.37	0.88	0.46	0.46	0.63			
AC0002	27	0.94	0.55	0.83	0.38	0.88	0.51	0.65	0.65	0.34			
AC0002	49	0.72	0.33	0.83	0.38	0.62	0.39	0.64	0.64	0.38			
AC0002	54	*****	*****	0.79	0.42	*****	*****	0.68	0.68	0.40			
TS0003	4	1.77	2.27	1.59	1.49	1.56	2.36	1.02	1.02	1.34			
TS0003	26	2.27	1.62	1.80	1.31	2.11	1.56	1.56	1.56	1.04			
TS0003	46	1.96	1.47	1.83	1.06	1.78	1.41	1.79	1.79	0.77			
TS0003	51	*****	*****	1.70	1.06	*****	*****	1.75	1.75	0.80			
TS0005	4	0.95	2.72	1.00	2.71	0.90	2.68	1.13	2.48				
TS0005	27	1.74	1.55	2.40	0.93	1.50	1.50	2.36	2.36	0.78			
TS0005	50	2.87	0.00	2.33	0.00	2.52	0.64	2.32	2.32	0.26			
TS0005	55	*****	*****	2.33	0.00	*****	*****	2.18	2.18	0.17			
Y50001	4	2.73	2.49	2.91	2.02	2.38	2.37	2.27	2.27	2.09			
Y50001	25	2.93	1.36	2.67	1.34	3.00	1.46	2.89	2.89	1.39			
Y50001	45	2.73	1.23	2.50	1.17	2.55	0.96	2.52	2.52	1.00			
JG0101	4	2.09	2.58	1.52	2.52	2.07	2.56	1.83	1.83	2.25			
JG0101	11	1.65	1.95	1.42	2.00	1.74	2.06	1.56	1.56	1.91			
JG0102	<	2.28	3.44	1.94	2.91	2.28	3.31	1.96	1.96	2.76			
JG0102	26	2.24	2.81	1.78	2.39	2.15	2.66	1.80	1.80	2.22			
JG0102	48	2.21	2.90	1.42	2.68	2.14	2.69	1.70	1.70	2.29			
JG0103	4	1.77	2.91	1.79	3.32	1.83	2.74	1.59	1.59	2.84			
JG0103	22	1.67	2.15	1.54	2.33	1.70	2.18	1.72	1.72	2.15			
JG0103	44	2.02	2.28	2.09	2.16	2.06	1.67	2.26	2.26	1.65			
JG0103	66	2.09	1.86	2.12	1.51	2.07	1.19	2.29	2.29	1.09			
JG0103	83	1.51	0.88	1.51	0.76	1.44	0.72	1.60	1.60	0.43			
JG0301	4	1.50	2.27	1.48	1.89	1.57	2.22	1.57	1.57	1.62			
JG0301	11	1.16	1.77	1.23	1.64	1.31	1.64	1.49	1.49	1.49			
JG0302	4	2.02	2.49	1.48	1.38	1.98	2.33	1.62	1.62	1.32			
JG0302	16	1.92	1.69	1.07	1.10	1.86	1.68	1.15	1.15	1.11			
JG0302	27	1.23	1.16	0.62	0.94	1.29	1.14	0.51	0.51	0.69			

(Continued)

(Sheet 11 of 12)

Table 11D (Concluded)

STATION	DEPTH FT	MODEL DATA										>>>>>>> HARMONIC ANALYSIS <<<<<<					
		**** BASE TEST ****			**** PLAN TEST ****			**** BASE TEST ****			**** PLAN TEST ****			>>>>>>>			
		MAX FLOOD	VELOCITY	FFS	MAX FLOOD	VELOCITY	FFS	MAX FLOOD	VELOCITY	FFS	MAX FLOOD	VELOCITY	FFS	MAX FLOOD	VELOCITY	FFS	MAX FLOOD
JG0321	4	1.64	2.56	1.74	2.28	1.82	2.49	1.67	2.14								
JN0202	4	1.16	1.73	0.65	1.04	1.23	1.48	0.71	0.83								
JN0202	12	1.06	1.03	0.59	0.58	1.04	0.93	0.58	0.53								
JN0203	4	1.09	2.91	0.81	1.75	1.13	2.51	0.81	1.76								
JN0203	20	0.93	1.43	0.91	1.39	1.05	1.28	0.85	1.07								
JN0204	4	1.62	2.67	1.13	2.27	1.33	2.71	1.03	2.19								
JN0204	26	2.11	1.84	1.83	1.89	2.04	1.95	1.82	1.68								
JN0204	48	2.27	0.70	2.62	0.74	2.04	0.73	2.60	0.65								
JN0204	55	*****	2.36	0.56	*****	*****	*****	2.42	0.46								
EH0202	4	1.23	1.30	0.91	0.98	0.78	1.22	0.58	0.97								
EH0202	25	1.46	0.83	0.98	0.43	1.20	0.90	0.72	0.37								
EH0202	46	1.09	0.73	0.42	0.00	0.98	0.54	0.16	0.05								
EH0202	55	*****	0.43	0.12	*****	*****	*****	0.11	0.06								
EH0203	4	0.54	1.08	0.52	1.20	0.59	1.03	0.53	1.05								
EH0203	22	1.24	0.83	0.96	0.69	1.04	0.81	0.75	0.67								
EH0203	40	1.14	0.70	0.49	0.22	1.01	0.62	0.19	0.14								
EH0501	4	0.45	0.65	0.11	0.42	0.30	0.45	0.09	0.27								
EH0501	22	0.59	0.49	0.25	0.00	0.41	0.28	0.09	0.03								
EH0501	39	0.59	0.32	0.45	0.72	0.31	0.30	0.42	0.60								
EH0501	45	*****	0.42	0.62	*****	*****	*****	0.43	0.52								
EH0701	4	0.42	0.62	0.25	0.25	0.25	0.47	0.17	0.22								
EH0701	19	0.55	1.21	0.45	1.00	0.61	0.92	0.53	0.85								
EH0701	35	0.65	1.08	0.42	0.45	0.69	0.77	0.42	0.29								
EH0701	40	*****	0.45	0.45	0.45	0.45	0.35	0.35	0.23								
EH0901	4	0.30	0.73	0.00	0.67	0.27	0.53	0.12	0.42								
EH0901	19	0.39	0.61	0.34	0.60	0.38	0.41	0.21	0.36								
EH0901	35	0.24	0.24	0.51	0.43	0.18	0.17	0.37	0.27								
EE0301	4	0.91	0.49	0.55	0.45	0.75	0.46	0.37	0.34								
EE0301	21	0.64	0.00	0.35	0.11	0.50	0.07	0.23	0.06								
WB0201	4	1.55	1.21	1.47	0.92	1.39	1.23	1.14	0.95								
WB0201	13	1.20	1.02	0.95	0.76	1.23	1.05	0.88	0.74								

(Sheet 12 of 12)

Table 12A

Maximum Flood and Ebb Velocities: Plan-Minus-Base Differences
Computed from Observed Model Data

STATION	DEPTH FT	TEST 1 *****				TEST 2 *****				TEST 3 *****				TEST 4 *****			
		MAX FLOOD VELOCITY DIFFERENCE	MAX EBB VELOCITY DIFFERENCE	FPS	FPS	MAX FLOOD VELOCITY DIFFERENCE	MAX EBB VELOCITY DIFFERENCE	FPS	FPS	MAX FLOOD VELOCITY DIFFERENCE	MAX EBB VELOCITY DIFFERENCE	FPS	FPS	MAX FLOOD VELOCITY DIFFERENCE	MAX EBB VELOCITY DIFFERENCE	FPS	FPS
CB0001	4	0.16	-0.37	-0.33	-0.14	0.10	-0.87	0.61	-0.87	0.12	-0.12	-0.12	-0.31	0.61	-0.87	0.61	-0.87
CB0001	18	0.11	+0.07	0.12	+0.07	0.28	-0.12	-0.12	-0.12	-0.19	-0.19	-0.19	-0.23	-0.12	-0.12	-0.12	-0.31
CB0001	32	-0.07	+0.00	-0.06	+0.33	-0.46	-0.28	-0.28	-0.28	-0.42	-0.42	-0.42	-0.23	-0.19	-0.19	-0.19	-0.23
CB0002	4	-0.15	-0.32	0.43	-0.34	0.22	-0.28	-0.28	-0.28	-0.22	-0.22	-0.22	-0.23	-0.11	-0.11	-0.11	-0.44
CB0002	20	-1.31	-0.03	0.28	-0.27	0.32	+0.22	+0.22	+0.22	0.24	0.24	0.24	-0.32	0.10	0.10	0.10	-0.32
CB0002	35	-0.21	-0.20	-0.09	-0.21	0.20	-0.20	-0.20	-0.20	-0.13	-0.13	-0.13	-0.11	-0.10	-0.10	-0.10	-0.11
CB0002	54	-0.36	-0.32	-0.04	-0.21	0.23	-0.23	-0.23	-0.23	-0.13	-0.13	-0.13	-0.11	-0.10	-0.10	-0.10	-0.11
CB0002	71	-0.47	-0.55	-0.13	-0.11	0.28	+0.71	+0.71	+0.71	-0.13	-0.13	-0.13	-0.05	-0.13	-0.13	-0.13	-0.05
CA0004	4	0.19	+0.16	-0.02	+0.66	-0.47	-0.47	-0.47	-0.47	-0.06	-0.06	-0.06	-0.04	-0.06	-0.06	-0.06	+0.10
CA0004	16	-0.07	+0.27	0.13	+0.42	-0.30	+0.18	+0.18	+0.18	-0.27	-0.27	-0.27	-0.15	-0.27	-0.27	-0.27	-0.15
CA0004	28	0.07	+0.11	0.60	+0.27	0.18	+0.21	+0.21	+0.21	-0.00	-0.00	-0.00	-0.28	-0.00	-0.00	-0.00	-0.28
CB0005	4	-0.52	+1.41	-0.26	+0.35	-0.12	-0.49	-0.49	-0.49	-0.08	-0.08	-0.08	-0.38	-0.08	-0.08	-0.08	-0.38
CB0005	15	0.43	+0.79	-0.27	-0.19	0.18	-0.13	-0.13	-0.13	-0.14	-0.14	-0.14	-0.14	-0.01	-0.01	-0.01	-0.14
CB0005	4	2.03	+3.09	-0.05	+0.21	0.25	-0.17	-0.17	-0.17	-0.16	-0.16	-0.16	-0.16	-0.08	-0.08	-0.08	-0.15
CE0008	24	1.83	+2.49	-0.39	+0.16	-0.00	+0.51	+0.51	+0.51	-0.16	-0.16	-0.16	-0.44	-0.16	-0.16	-0.16	-0.44
CB0006	43	1.33	+2.13	-0.01	-0.04	0.10	-0.25	-0.25	-0.25	-0.52	-0.52	-0.52	-0.71	-0.52	-0.52	-0.52	-0.71
C90009	4	-0.62	+0.44	-0.17	-0.50	-0.04	-0.04	-0.04	-0.04	-0.01	-0.01	-0.01	-0.11	-0.01	-0.01	-0.01	-0.11
C90009	16	-0.90	-0.60	-0.21	-0.26	-0.30	+0.03	+0.03	+0.03	-0.12	-0.12	-0.12	-0.01	-0.12	-0.12	-0.12	-0.01
CB0101	4	-0.12	-0.07	-0.20	-0.21	-0.13	-0.02	-0.02	-0.02	-0.31	-0.31	-0.31	-0.74	-0.16	-0.16	-0.16	-0.74
CB0101	13	0.50	+0.19	0.04	-0.11	0.02	+0.07	+0.07	+0.07	-0.14	-0.14	-0.14	-0.27	-0.14	-0.14	-0.14	-0.27
CB0103	4	0.10	-0.60	-0.18	-0.24	-0.27	+0.12	+0.12	+0.12	-0.06	-0.06	-0.06	-0.14	-0.06	-0.06	-0.06	-0.14
CB0103	14	0.07	+0.04	-0.25	-0.17	-0.14	-0.10	-0.10	-0.10	-0.05	-0.05	-0.05	-0.15	-0.05	-0.05	-0.05	-0.15
CB0103	24	-0.37	-0.22	-0.24	-0.17	-0.20	-0.49	-0.49	-0.49	-0.28	-0.28	-0.28	-0.00	-0.28	-0.28	-0.28	-0.00
CB0105	4	0.08	-0.01	0.10	-0.96	-0.20	-0.37	-0.37	-0.37	-0.09	-0.09	-0.09	-0.38	-0.09	-0.09	-0.09	-0.38
CB0105	20	-0.16	-0.19	0.26	-1.15	-0.14	+0.22	+0.22	+0.22	-0.16	-0.16	-0.16	-0.21	-0.16	-0.16	-0.16	-0.21
CB0105	37	0.24	+3.07	-0.31	-0.25	-0.43	-0.23	-0.23	-0.23	-0.25	-0.25	-0.25	-0.14	-0.25	-0.25	-0.25	-0.14
CB0107	4	0.20	-0.28	-0.22	-0.26	0.13	+0.49	+0.49	+0.49	-0.08	-0.08	-0.08	-0.45	-0.08	-0.08	-0.08	-0.45
CB0107	15	-0.23	-0.09	-0.16	-0.19	-0.16	-0.16	-0.16	-0.16	-0.07	-0.07	-0.07	-0.25	-0.07	-0.07	-0.07	-0.25
CB0107	27	-0.28	+0.18	-0.35	-0.35	-0.06	+0.13	+0.13	+0.13	-0.07	-0.07	-0.07	-0.37	-0.07	-0.07	-0.07	-0.37
CB0109	4	-0.20	+0.13	0.19	-0.00	-0.26	+1.35	+1.35	+1.35	-0.19	-0.19	-0.19	-0.09	-0.19	-0.19	-0.19	-0.09
CB0109	39	-0.14	+0.26	-0.31	-0.11	-0.07	-0.05	-0.05	-0.05	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
CB0109	75	-0.45	-0.03	0.05	-0.12	-0.12	-0.03	-0.03	-0.03	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06

(Continued)

(Sheet 1 of 10)

Table 12A (Continued)

STATION	DEPTH FT	TEST 1				TEST 2				TEST 3				TEST 4			
		MAX FLOOD VELOCITY DIFFERENCE FPS	MIN FLOOD VELOCITY DIFFERENCE FPS	MAX EBB VELOCITY DIFFERENCE FPS	MAX FLOOD VELOCITY DIFFERENCE FPS	MAX EBB VELOCITY DIFFERENCE FPS											
CB0110	4	-0.11	+0.09	-0.33	+0.07	0.13	-0.36	0.07	-0.36	0.07	-0.30	-0.04	-0.26	-0.04	+0.13		
CB0110	15	0.14	+0.11	-0.16	+0.17	-0.04	-0.26	-0.13	-0.04	-0.04	-0.18	-0.30	-0.43	-0.30	-0.18		
AC00002	4	-0.24	-0.21	-0.27	+0.02	-0.36	-0.36	-0.43	-0.36	-0.30	-0.12	-0.12	-0.39	-0.39	-0.17		
AC00002	27	-0.24	-0.50	-0.06	-0.09	-0.12	-0.12	-0.39	-0.12	-0.39	-0.12	-0.12	-0.12	-0.12	-0.17		
AC00002	49	0.02	+0.07	0.08	+0.01	0.11	+0.19	0.11	0.11	0.11	0.11	0.11	0.11	0.11	+0.05		
AC00002	54	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****		
TS00003	4	-0.39	-0.74	0.05	-0.31	-0.00	-0.46	-0.46	-0.00	-0.18	-0.73	-0.73	-0.73	-0.73	-0.73		
TS00003	26	-0.62	-0.59	0.23	-0.01	-0.17	-0.09	-0.09	-0.17	-0.47	-0.32	-0.32	-0.32	-0.32	-0.32		
TS00003	46	0.15	-0.20	0.27	+0.11	0.64	+0.32	+0.32	0.64	-0.13	-0.41	-0.41	-0.41	-0.41	-0.41		
TS00003	51	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****		
TS00005	4	-0.19	+0.32	0.00	-0.82	-0.18	-0.29	-0.29	-0.18	0.04	-0.00	-0.00	-0.00	-0.00	-0.00		
TS00005	27	-0.29	-0.07	0.37	+0.28	-0.51	-0.11	-0.11	-0.51	0.66	-0.62	-0.62	-0.62	-0.62	-0.62		
TS00005	50	-0.03	+0.20	-0.04	+0.69	0.16	+0.49	+0.49	0.16	-0.54	-0.00	-0.00	-0.00	-0.00	-0.00		
TS00005	55	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****	* ****		
YS00001	4	-0.32	-0.26	-0.27	-0.03	0.39	+0.22	+0.22	0.18	-0.47	-0.47	-0.47	-0.47	-0.47	-0.47		
YS00001	25	-0.41	-0.29	0.63	-0.19	-0.36	+0.26	+0.26	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06		
YS00001	45	0.10	+0.03	-0.43	-0.18	0.53	+0.05	+0.05	0.53	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23		
JG0101	4	-0.14	+0.38	-0.26	-0.45	-0.36	-0.55	-0.55	-0.36	-0.57	-0.14	-0.14	-0.14	-0.14	-0.14		
JG0101	11	-0.31	-0.29	-0.44	-0.22	-0.06	-0.15	-0.15	-0.06	-0.23	-0.05	-0.05	-0.05	-0.05	-0.05		
JG0102	4	-0.57	-0.98	0.03	+0.49	-0.31	-1.14	-1.14	-0.31	-0.34	-0.53	-0.53	-0.53	-0.53	-0.53		
JG0102	26	-0.11	-0.44	-0.02	+0.43	-0.19	-0.80	-0.80	-0.19	-0.47	-0.43	-0.43	-0.43	-0.43	-0.43		
JG0102	48	-0.58	-0.86	-0.26	+0.49	-0.07	-0.27	-0.27	-0.07	-0.79	-0.22	-0.22	-0.22	-0.22	-0.22		
JG0103	4	-0.09	-0.45	0.07	+0.34	-0.30	-0.09	-0.09	-0.30	0.02	-0.40	-0.40	-0.40	-0.40	-0.40		
JG0103	22	0.43	-0.16	0.29	-0.14	-0.35	-0.24	-0.24	-0.14	-0.13	-0.18	-0.18	-0.18	-0.18	-0.18		
JG0103	44	0.01	-0.44	0.13	+0.25	0.20	+0.45	+0.45	0.20	0.87	-0.12	-0.12	-0.12	-0.12	-0.12		
JG0103	66	0.25	+1.33	0.10	-0.10	0.34	+0.52	+0.52	0.34	0.04	-0.35	-0.35	-0.35	-0.35	-0.35		
JG0103	83	1.44	+1.55	-0.05	+0.01	0.06	+0.15	+0.15	0.06	-0.00	-0.12	-0.12	-0.12	-0.12	-0.12		
JG0311	4	0.38	-0.08	0.45	+0.30	0.23	-0.80	-0.80	0.23	-0.02	-0.38	-0.38	-0.38	-0.38	-0.38		
JG0311	11	0.13	+0.01	0.56	+0.16	0.41	-0.03	-0.03	0.41	0.07	-0.13	-0.13	-0.13	-0.13	-0.13		
JG0302	4	0.38	+0.36	-0.06	+0.09	-0.25	-0.42	-0.42	-0.06	-0.54	-1.11	-1.11	-1.11	-1.11	-1.11		
JG0302	16	0.36	+0.24	-0.32	-0.10	-0.27	-0.21	-0.21	-0.10	-0.86	-0.60	-0.60	-0.60	-0.60	-0.60		
JG0302	27	0.36	+0.47	-0.24	+0.33	-0.26	+0.52	+0.52	-0.24	-0.61	-0.23	-0.23	-0.23	-0.23	-0.23		

(Continued)

(Sheet 2 of 10)

Table 12A (Concluded)

STATION	DEPTH FT	TEST 1 *****				TEST 2 *****				TEST 3 *****				TEST 4 *****			
		MAX FLOOD		MAX EBB		MAX FLOOD		MAX EBB		MAX FLOOD		MAX EBB		MAX FLOOD		MAX EBB	
		VELOCITY	DIFFERENCE	VELOCITY	DIFFERENCE												
		FPS	FPS	FPS	FPS												
JG0321	4	-0.24	-0.52	0.08	+0.13	-0.23	+0.13	0.10	-0.29	-0.10	-0.10	-0.13	-0.10	-0.10	-0.10	-0.10	-0.10
JN0202	4	0.02	+0.41	-0.06	+0.11	-0.10	-0.39	-0.51	-0.69	-0.09	-0.09	-0.09	-0.47	-0.45	-0.47	-0.47	-0.45
JN0202	12	-0.48	-0.58	-0.13	-0.16	0.04	-0.09	-0.09	-0.27	-0.27	-0.27	-0.18	-0.17	-0.17	-0.17	-0.17	-0.17
JN0203	4	-0.13	-0.31	-0.19	+0.03	-0.18	+0.09	+0.09	-0.27	-0.27	-0.27	-0.15	-0.02	-0.02	-0.02	-0.02	-0.04
JN0203	20	-0.26	+0.10	0.00	+0.46	-0.15	+0.15	-0.15	-0.49	-0.49	-0.49	-0.53	-0.49	-0.49	-0.49	-0.49	-0.49
JN0204	4	-0.72	+1.24	0.24	+0.57	-0.53	-0.09	-0.09	-0.46	-0.46	-0.46	-0.48	-0.28	-0.28	-0.28	-0.28	-0.40
JN0204	26	-0.12	-0.05	0.03	+0.25	-0.25	-0.46	-0.46	-0.46	-0.46	-0.46	-0.46	-0.28	-0.28	-0.28	-0.28	+0.04
JN0204	48	0.36	-0.33	0.43	-0.26	-0.55	-0.19	-0.19	-0.35	-0.35	-0.35	-0.35	-0.19	-0.19	-0.19	-0.19	+0.03
JN0204	55	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
EH0202	4	-0.05	-0.47	-0.22	-0.19	-0.09	-0.60	-0.60	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.32
EH0202	25	0.03	+0.02	0.35	+0.38	-0.30	-0.37	-0.37	-0.48	-0.48	-0.48	-0.48	-0.48	-0.48	-0.48	-0.48	-0.41
EH0202	45	-1.20	-0.63	0.62	+0.21	-0.44	+0.20	-0.44	-0.67	-0.67	-0.67	-0.67	-0.67	-0.67	-0.67	-0.67	-0.73
EH0202	55	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
EH0202	4	-0.30	-0.20	-0.21	-0.40	-0.62	-0.16	-0.16	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	+0.12
EH0203	22	-0.07	-0.24	-0.05	-0.07	-0.20	-0.10	-0.10	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.28	-0.13
EH0203	40	-0.90	-0.75	-0.90	-0.39	-0.10	-0.51	-0.51	-0.66	-0.66	-0.66	-0.66	-0.66	-0.66	-0.66	-0.66	-0.49
EH0501	4	0.09	-0.24	0.25	+0.25	0.30	-0.52	-0.52	-0.34	-0.34	-0.34	-0.34	-0.34	-0.34	-0.34	-0.34	-0.24
EH0501	22	-0.18	-0.16	-0.30	-0.11	-0.49	-0.17	-0.17	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.49
EH0501	39	-0.16	+0.22	-0.12	-0.25	-0.03	-0.03	-0.03	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	+0.39
EH0501	45	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
EH0701	4	-0.08	-0.83	0.22	-0.38	-0.33	-1.54	-1.54	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18	-0.38
EH0701	19	-0.00	-0.08	-0.03	-0.17	-0.45	-0.37	-0.37	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10	-0.21
EH0701	35	-0.31	-0.62	0.17	+0.27	-0.47	-0.62	-0.62	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.63
EH0701	40	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
EH0901	4	0.12	-0.65	0.00	+0.03	-0.09	-0.45	-0.45	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.06
EH0901	19	0.08	-0.91	-0.44	+0.56	0.21	-0.53	-0.53	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.00
EH0901	35	-0.08	-0.41	0.22	-0.03	-0.07	+0.23	+0.23	-0.27	-0.27	-0.27	-0.27	-0.27	-0.27	-0.27	-0.27	+0.19
EE0201	4	0.11	+0.48	-0.38	-0.02	0.21	-0.21	-0.21	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.36	-0.04
EE0201	21	-0.34	-0.00	-0.97	-0.42	-0.04	-0.17	-0.17	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22	-0.22
EE0201	4	0.30	+0.23	-0.17	-0.18	-0.08	-0.15	-0.15	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.08	-0.11
EE0201	13	0.14	+0.17	-0.18	-0.09	-0.15	-0.24	-0.24	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.15	-0.26

(Sheet 3 of 10)

Table 12B

Maximum Flood and Ebb Velocities: Plan-Minus-Base Differences
Computed from Least-Squares Cosine Curve Fitted to Model Data

STATION	DEPTH FT	TEST 1 *****						TEST 2 *****						TEST 3 *****						TEST 4 *****					
		MAX FLOOD		MAX EBB		MAX FLOOD		MAX EBB		MAX FLOOD		MAX EBB		MAX FLOOD		MAX EBB		MAX FLOOD		MAX EBB					
		VELOCITY	DIFFERENCE	VELOCITY	DIFFERENCE	VELOCITY	DIFFERENCE	VELOCITY	DIFFERENCE	VELOCITY	DIFFERENCE	VELOCITY	DIFFERENCE	VELOCITY	DIFFERENCE	VELOCITY	DIFFERENCE	VELOCITY	DIFFERENCE	VELOCITY	DIFFERENCE				
FPS	FPS	FPS	FPS	FPS	FPS	FPS	FPS	FPS	FPS	FPS	FPS	FPS	FPS	FPS	FPS	FPS	FPS	FPS	FPS	FPS	FPS				
CB0001	4	0.16	-0.37	0.06	-0.17	-0.01	-0.53	0.32	-0.70	-0.21	-0.55	-0.31	-0.21	-0.55	-0.38	-0.05	-0.29	-0.25	-0.20	-0.27	-0.27				
CB0001	18	-0.15	-0.09	0.07	0.12	-0.01	-0.31	-0.13	-0.53	-0.21	-0.55	-0.15	-0.25	-0.38	-0.20	-0.29	-0.29	-0.20	-0.20	-0.20	-0.20				
CB0001	32	0.04	-0.14	0.00	0.25	-0.15	-0.38	-0.15	-0.38	-0.05	-0.55	-0.15	-0.25	-0.38	-0.20	-0.29	-0.29	-0.25	-0.25	-0.25	-0.25				
CB0002	4	-0.15	-0.19	0.72	-0.66	0.09	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20	-0.20				
CB0002	20	-0.83	-0.31	-0.03	-0.32	0.06	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15				
CB0002	35	0.04	-0.14	-0.12	-0.37	0.08	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13				
CB0002	54	-0.18	-0.35	-0.21	-0.17	-0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12				
CB0002	71	-0.69	-0.49	-0.25	-0.21	0.27	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30				
CB0004	4	0.16	0.19	-0.06	0.71	-0.47	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38				
CB0004	16	0.07	0.04	0.22	0.42	-0.27	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02				
CB0004	28	0.02	-0.13	0.48	0.44	0.69	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20				
C90006	4	-0.18	1.30	-0.05	0.31	-0.34	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19				
C90006	15	0.31	0.63	-0.12	-0.14	0.17	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07	-0.07				
CB0008	4	1.99	3.06	-0.01	0.35	0.17	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11				
CB0008	24	1.95	2.39	-0.32	0.26	0.25	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14				
CB0008	43	1.56	1.84	0.12	0.02	0.12	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02				
CB0009	4	-0.37	0.32	-0.31	-0.41	-0.33	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39				
CB0009	16	-0.61	-0.81	-0.17	-0.12	-0.17	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12				
CB0101	4	-0.14	-0.07	-0.42	-0.36	-0.11	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24				
CB0101	13	0.17	0.32	-0.14	-0.28	-0.10	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05	-0.05				
CB0103	4	-0.10	-0.04	-0.79	-0.45	-0.45	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23				
CB0103	14	-0.09	-0.05	-0.30	-0.49	-0.22	-0.17	-0.17	-0.17	-0.17	-0.17	-0.17	-0.17	-0.17	-0.17	-0.17	-0.17	-0.17	-0.17	-0.17	-0.17				
CB0103	24	-0.29	-0.32	-0.50	-0.41	-0.41	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45	-0.45				
CB0105	4	-0.08	-0.13	-0.19	-0.65	-0.31	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29				
CB0105	20	-0.10	-0.07	0.12	-1.05	-0.95	-0.95	-0.95	-0.95	-0.95	-0.95	-0.95	-0.95	-0.95	-0.95	-0.95	-0.95	-0.95	-0.95	-0.95	-0.95				
CB0105	37	0.50	0.66	-0.24	-0.22	-0.46	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33	-0.33				
CB0107	4	-0.06	-0.15	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29	-0.29				
CB0107	15	-0.22	-0.35	-0.64	-0.04	-0.04	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01				
CB0107	27	-0.13	-0.10	-0.33	-0.28	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04				
CB0109	4	-0.03	0.14	0.08	0.23	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31				
C90109	39	-0.19	0.24	-0.17	0.06	0.06	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03				
C90109	75	-0.43	-0.05	0.11	-0.04	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24	-0.24				

(Continued)

Table 12B (Continued)

STATION	DEPTH FT	TEST 1 *****			TEST 2 *****			TEST 3 *****			TEST 4 *****		
		MAX FLOOD VELOCITY DIFFERENCE FPS	MAX EBB VELOCITY DIFFERENCE FPS										
CB0110	4	-0.24	-0.01	-0.24	-0.05	-0.32	-0.28	-0.27	-0.09	-0.27	-0.09		
CB0110	15	-0.04	0.04	-0.11	0.19	-0.11	-0.22	0.07	0.13	0.07	0.13		
AC0002	4	-0.20	-0.19	-0.23	-0.15	-0.11	-0.68	0.09	-0.25	0.09	-0.25		
AC0002	27	-0.15	-0.33	-0.19	-0.17	-0.25	-0.23	-0.23	-0.18	-0.23	-0.18		
AC0002	49	-0.09	-0.02	-0.10	0.05	0.12	0.13	0.02	-0.09	0.02	-0.09		
AC0002	54	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****		
T50003	4	-0.41	-0.45	-0.06	-0.27	-0.06	-0.39	-0.54	-1.02	-0.54	-1.02		
T50003	26	-0.31	-0.31	-0.06	0.10	-0.17	-0.54	-0.54	-0.54	-0.54	-0.54		
T50003	46	0.11	-0.24	0.31	0.19	0.35	0.15	0.00	-0.64	0.00	-0.64		
T50003	51	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****		
T50005	4	-0.13	-0.12	-0.08	-0.31	-0.21	-0.38	0.23	-0.27	0.23	-0.27		
T50005	27	-0.27	-0.42	0.60	0.10	-0.32	-0.03	0.86	-0.72	0.86	-0.72		
T50005	50	-0.03	-0.38	0.09	0.18	0.20	0.07	-0.20	-0.37	-0.20	-0.37		
T50005	55	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****		
Y50001	4	-0.57	-0.25	-0.40	-0.22	0.34	-0.09	-0.11	-0.29	-0.11	-0.29		
Y50001	25	-0.39	-0.06	1.18	-0.17	0.00	-0.28	-0.11	-0.07	-0.11	-0.07		
Y50001	45	0.05	0.08	-0.50	-0.00	0.37	-0.14	-0.03	0.04	-0.03	0.04		
JG0101	4	-0.13	0.60	-0.27	-0.13	-0.21	-0.41	-0.24	-0.31	-0.24	-0.31		
JG0101	11	-0.34	-0.09	-0.36	-0.17	-0.19	-0.02	-0.18	-0.15	-0.18	-0.15		
JG0102	4	-0.69	-0.97	-0.14	0.35	-0.47	-0.87	-0.32	-0.55	-0.32	-0.55		
JG0102	26	-0.27	-0.32	-0.15	0.04	-0.35	-0.52	-0.35	-0.43	-0.35	-0.43		
JG0102	48	-0.79	-1.10	0.19	-0.05	-0.16	-0.41	-0.44	-0.41	-0.44	-0.41		
JG0103	4	-0.07	0.07	0.00	0.30	-0.45	-0.19	-0.24	0.10	-0.24	0.10		
JG0103	22	-0.33	0.05	-0.00	-0.32	-0.38	-0.54	0.02	-0.03	0.02	-0.03		
JG0103	44	-0.12	0.11	0.34	0.23	0.35	0.12	0.20	-0.02	0.20	-0.02		
JG0103	66	0.95	0.65	0.09	0.03	0.45	0.29	0.22	-0.09	0.22	-0.09		
JG0103	83	1.46	0.54	-0.20	-0.00	0.15	0.28	0.16	-0.28	0.16	-0.28		
JG0311	4	0.22	0.01	0.32	0.41	0.06	-0.46	0.00	-0.60	0.00	-0.60		
JG0311	11	-0.02	-0.06	0.41	0.32	0.09	0.08	0.09	-0.14	0.09	-0.14		
JG0302	4	0.27	0.51	0.05	-0.10	-0.25	-0.48	-0.36	-1.01	-0.36	-1.01		
JG0302	16	0.34	0.35	-0.21	-0.17	-0.17	-0.28	-0.71	-0.57	-0.71	-0.57		
JG0302	27	0.21	0.34	0.03	0.23	-0.07	0.06	-0.78	-0.45	-0.78	-0.45		

(Continued)

(Sheet 5 of 10)

Table 12B (Concluded)

STATION	DEPTH FT	TEST 1 *****				TEST 2 *****				TEST 3 *****				TEST 4 *****			
		MAX FLOOD VELOCITY. DIFFERENCE FPS	MAX EBB VELOCITY. DIFFERENCE FPS														
JG0321	4	-0.42	-0.49	0.06	0.11	-0.15	-0.23	-0.16	-0.34	-0.16	-0.23	-0.15	-0.34				
JN0202	4	0.06	0.37	-0.05	0.17	-0.17	-0.35	-0.52	-0.65	-0.17	-0.35	-0.17	-0.65				
JN0202	12	-0.42	-0.54	-0.05	0.04	-0.13	-0.12	-0.46	-0.40	-0.13	-0.12	-0.46	-0.40				
JN0203	4	-0.16	-0.18	-0.12	-0.25	0.01	0.17	-0.32	-0.74	0.01	0.17	-0.32	-0.74				
JN0203	20	-0.12	0.04	-0.03	0.10	-0.10	0.09	-0.21	-0.21	-0.10	0.09	-0.21	-0.21				
JN0204	4	-0.37	0.89	0.25	0.33	-0.52	-0.31	-0.29	-0.52	-0.31	-0.29	-0.22	-0.16				
JN0204	26	-0.11	-0.22	-0.02	-0.03	-0.43	-0.69	-0.22	-0.22	-0.43	-0.69	-0.22	-0.16				
JN0204	48	0.25	-0.16	0.15	-0.04	-0.34	-0.47	0.56	-0.08	-0.34	-0.47	0.56	-0.08				
JN0204	55	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****				
JN0204	55	-0.05	-0.19	-0.09	-0.17	-0.30	-0.51	-0.20	-0.25	-0.30	-0.51	-0.20	-0.25				
EH0202	4	0.07	-0.16	0.53	0.32	-0.28	-0.31	-0.48	-0.53	-0.32	-0.31	-0.48	-0.53				
EH0202	25	-1.19	-0.79	0.44	0.49	-0.38	0.11	-0.74	-0.49	-0.38	0.11	-0.74	-0.49				
EH0202	46	55	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****				
EH0202	46	-0.03	-0.00	-0.14	-0.54	-0.60	-0.42	-0.06	0.03	-0.03	-0.42	-0.06	0.03				
EH0203	4	0.07	-0.25	-0.04	-0.01	-0.14	-0.29	-0.29	-0.13	-0.14	-0.29	-0.29	-0.13				
EH0203	22	-1.01	-0.70	0.01	0.18	-0.37	-0.43	-0.82	-0.47	0.01	0.18	-0.37	-0.47				
EH0203	40	4	-0.13	-0.15	0.10	0.13	0.12	0.67	-0.22	-0.13	0.12	0.67	-0.22				
EH0501	4	-0.13	-0.08	-0.05	-0.17	-0.55	-0.34	-0.33	-0.26	-0.55	-0.34	-0.33	-0.26				
EH0501	22	-0.11	0.34	-0.15	-0.41	0.03	0.02	0.11	0.30	0.03	0.02	0.11	0.30				
EH0501	39	45	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****				
EH0701	4	-0.24	-0.67	0.07	-0.26	-0.34	-0.76	-0.09	-0.25	-0.34	-0.76	-0.09	-0.25				
EH0701	19	-0.05	-0.11	0.04	-0.20	-0.55	-0.58	-0.08	-0.07	-0.55	-0.58	-0.08	-0.07				
EH0701	35	-0.17	-0.35	0.18	0.46	-0.44	-0.36	-0.27	-0.47	0.18	-0.44	-0.36	-0.47				
EH0701	40	4	0.02	-0.50	0.03	-0.05	0.02	0.05	0.11	-0.05	0.02	0.05	0.11				
EH0901	19	-0.12	-0.36	-0.23	0.08	-0.06	-0.16	-0.16	-0.05	-0.23	-0.08	-0.16	-0.05				
EH0901	35	-0.15	-0.16	0.03	-0.01	0.03	-0.01	0.20	0.10	0.03	-0.01	0.20	0.10				
EH0901	40	4	0.27	0.20	-0.19	-0.12	0.21	0.21	-0.12	-0.19	-0.12	0.21	-0.12				
EH0901	41	-0.17	-0.16	-0.15	-0.75	-0.49	-0.65	-0.27	-0.02	-0.15	-0.49	-0.65	-0.02				
EH0901	41	-0.61	-0.50	-0.37	-0.53	-0.53	-0.53	-0.24	-0.38	-0.53	-0.53	-0.24	-0.38				
EH0901	41	4	0.15	0.15	-0.15	-0.15	0.15	0.15	-0.15	-0.15	0.15	-0.15	-0.15				
EH0901	41	4	19	35	40	40	40	40	40	40	40	40	40				

(Sheet 6 of 10)

Table 12C

Maximum Flood Velocities: Plan-Minus-Base Differences
Plan-Minus-Base Differences: Summary Statistics (Model Data)

CLASS INTERVAL		TEST 1 ***		TEST 2 ***		TEST 3 ***		TEST 4 ***		*** OVERALL ***
		MAXIMUM FLOOD FREQ.	RELATIVE FREQ.							
GREATER THAN 0.8 FPS	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
0.7 < DIFF < 0.8 FPS	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000
0.6 < DIFF < 0.7 FPS	0	0.000	2	0.023	1	0.011	2	0.023	5	0.014
0.5 < DIFF < 0.6 FPS	0	0.000	2	0.023	1	0.011	0	0.000	3	0.009
0.4 < DIFF < 0.5 FPS	3	0.036	3	0.034	1	0.011	0	0.000	7	0.020
0.3 < DIFF < 0.4 FPS	6	0.071	3	0.034	4	0.045	2	0.023	15	0.043
0.2 < DIFF < 0.3 FPS	2	0.024	9	0.102	8	0.091	1	0.011	20	0.057
0.1 < DIFF < 0.2 FPS	9	0.107	6	0.058	9	0.102	3	0.034	27	0.078
0.0 < DIFF < 0.1 FPS	11	0.131	9	0.102	5	0.057	13	0.148	38	0.109
-0.1 < DIFF < 0.0 FPS	10	0.119	19	0.216	15	0.170	15	0.170	59	0.170
-0.2 < DIFF < -0.1 FPS	14	0.167	10	0.114	14	0.159	17	0.193	55	0.158
-0.3 < DIFF < -0.2 FPS	8	0.095	15	0.170	9	0.102	10	0.114	42	0.121
-0.4 < DIFF < -0.3 FPS	7	0.093	6	0.068	9	0.102	7	0.080	29	0.083
-0.5 < DIFF < -0.4 FPS	4	0.048	3	0.034	8	0.091	6	0.068	21	0.060
-0.6 < DIFF < -0.5 FPS	3	0.036	0	0.000	3	0.034	6	0.068	12	0.034
-0.7 < DIFF < -0.6 FPS	2	0.024	0	0.000	1	0.011	4	0.045	7	0.020
-0.8 < DIFF < -0.7 FPS	1	0.012	0	0.000	0	0.000	1	0.011	2	0.006
LESS THAN -0.8 FPS	4	0.048	1	0.011	0	0.000	1	0.011	6	0.017
NUMBER IN SAMPLE		84	63	83	88	88	88	88	348	
MEAN DIFFERENCE (FPS)		-0.13	-0.02	-0.03	-0.17	-0.03	-0.17	-0.10	-0.10	
STANDARD DEVIATION (FPS)		0.34	0.27	0.27	0.28	0.27	0.28	0.29	0.29	

(Sheet 7 of 10)

Table 12D

Maximum Ebb Velocities: Plan-Minus-Base Differences
 Plan-Minus-Base Differences: Summary Statistics (Model Data)

CLASS INTERVAL	TEST 1 MAXIMUM EBB FREQ. RELATIVE FREQ.	TEST 2 MAXIMUM EBB FREQ. RELATIVE FREQ.		TEST 3 MAXIMUM EBB FREQ. RELATIVE FREQ.		TEST 4 MAXIMUM EBB FREQ. RELATIVE FREQ.		OVERALL *** MAXIMUM EBB FREQ. RELATIVE FREQ.
		TEST 1 MAXIMUM EBB FREQ. RELATIVE FREQ.	TEST 2 MAXIMUM EBB FREQ. RELATIVE FREQ.	TEST 3 MAXIMUM EBB FREQ. RELATIVE FREQ.	TEST 4 MAXIMUM EBB FREQ. RELATIVE FREQ.	TEST 3 MAXIMUM EBB FREQ. RELATIVE FREQ.	TEST 4 MAXIMUM EBB FREQ. RELATIVE FREQ.	
GREATER THAN 0.8 FPS	4 0.048	3 0.034	5 0.057	4 0.245	16 0.046			
0.7 < DIFF < 0.8 FPS	2 0.024	0 0.000	0 0.398	4 0.045	6 0.017			
0.6 < DIFF < 0.7 FPS	3 0.035	0 0.000	2 0.023	3 0.034	8 0.023			
0.5 < DIFF < 0.6 FPS	5 0.060	0 0.000	3 0.034	2 0.023	10 0.029			
0.4 < DIFF < 0.5 FPS	5 0.050	4 0.045	7 0.060	10 0.114	26 0.075			
0.3 < DIFF < 0.4 FPS	6 0.071	4 0.045	7 0.058	12 0.136	29 0.084			
0.2 < DIFF < 0.3 FPS	11 0.131	11 0.125	10 0.115	13 0.148	45 0.130			
0.1 < DIFF < 0.2 FPS	4 0.048	17 0.193	11 0.126	11 0.125	43 0.124			
0.0 < DIFF < 0.1 FPS	9 0.107	9 0.102	10 0.115	11 0.125	39 0.112			
-0.1 < DIFF < 0.0 FPS	11 0.131	10 0.114	5 0.057	9 0.102	35 0.101			
-0.2 < DIFF < -0.1 FPS	8 0.095	6 0.068	10 0.115	7 0.080	31 0.089			
-0.3 < DIFF < -0.2 FPS	5 0.060	8 0.091	8 0.092	8 0.090	21 0.091			
-0.4 < DIFF < -0.3 FPS	3 0.036	8 0.091	1 0.011	1 0.011	13 0.037			
-0.5 < DIFF < -0.4 FPS	4 0.048	5 0.057	3 0.034	1 0.011	13 0.037			
-0.6 < DIFF < -0.5 FPS	0 0.000	1 0.011	3 0.034	0 0.000	4 0.012			
-0.7 < DIFF < -0.6 FPS	0 0.000	2 0.023	0 0.000	0 0.000	2 0.006			
-0.8 < DIFF < -0.7 FPS	1 0.012	0 0.000	1 0.011	0 0.000	2 0.006			
LESS THAN -0.8 FPS	3 0.036	0 0.000	1 0.311	2 0.353	4 0.012			
NUMBER IN SAMPLE	34	53	57	53	53			
AVERAGE DIFFERENCE (FPS)	0.33	0.42	2.13	2.11	2.11			
STANDARD DEVIATION (FPS)	0.45	0.52	3.12	3.15	3.15			

(Sheet 8 of 10)

Table 12E

Maximum Flood Velocities: Plan-Minus-Base Differences
Plan-Minus-Base Differences: Summary Statistics (From Harmonic Analysis)

CLASS INTERVAL	TEST 1 *** MAXIMUM FLOOD FREQ. RELATIVE FREQ.	TEST 2 *** MAXIMUM FLOOD FREQ. RELATIVE FREQ.	TEST 3 *** MAXIMUM FLOOD FREQ. RELATIVE FREQ.	TEST 4 *** MAXIMUM FLOOD FREQ. RELATIVE FREQ.	OVERALL ***	
					FREQ.	FREQ.
GREATER THAN 0.8 FPS	1 0.012	1 0.011	0 0.000	1 0.011	1 0.000	3 0.009
0.7 < DIFF < 0.8 FPS	0 0.000	1 0.000	0 0.000	0 0.000	0 0.000	1 0.003
0.6 < DIFF < 0.7 FPS	0 0.000	0 0.000	0 0.000	0 0.000	0 0.000	0 0.000
0.5 < DIFF < 0.6 FPS	0 0.000	2 0.023	0 0.000	1 0.011	1 0.011	3 0.009
0.4 < DIFF < 0.5 FPS	1 0.012	3 0.034	1 0.011	0 0.000	0 0.000	5 0.014
0.3 < DIFF < 0.4 FPS	3 0.035	3 0.034	5 0.057	1 0.011	1 0.011	12 0.034
0.2 < DIFF < 0.3 FPS	5 0.060	2 0.023	4 0.045	3 0.034	3 0.034	14 0.040
0.1 < DIFF < 0.2 FPS	5 0.060	6 0.068	7 0.080	3 0.034	3 0.034	21 0.060
0.0 < DIFF < 0.1 FPS	9 0.107	16 0.182	12 0.136	10 0.114	10 0.114	47 0.135
-0.1 < DIFF < 0.0 FPS	15 0.179	18 0.205	11 0.125	13 0.148	13 0.148	57 0.164
-0.2 < DIFF < -0.1 FPS	21 0.250	15 0.170	16 0.182	15 0.170	15 0.170	67 0.193
-0.3 < DIFF < -0.2 FPS	7 0.083	11 0.125	10 0.114	19 0.216	19 0.216	47 0.135
-0.4 < DIFF < -0.3 FPS	5 0.060	5 0.057	11 0.125	8 0.091	8 0.091	29 0.083
-0.5 < DIFF < -0.4 FPS	4 0.048	3 0.034	7 0.080	4 0.045	4 0.045	18 0.052
-0.6 < DIFF < -0.5 FPS	1 0.012	1 0.011	3 0.034	5 0.057	5 0.057	10 0.029
-0.7 < DIFF < -0.6 FPS	3 0.036	0 0.000	1 0.011	1 0.011	1 0.011	5 0.014
LESS THAN -0.8 FPS	3 0.036	0 0.000	0 0.000	1 0.011	1 0.011	4 0.011
NUMBER IN SAMPLE	84	88	88	88	88	348
MEAN DIFFERENCE (FPS)	-0.13	-0.03	-0.11	-0.18	-0.11	-0.11
STANDARD DEVIATION (FPS)	0.31	0.24	0.24	0.27	0.28	0.28

(Sheet 9 of 10)

Table 12F

Maximum Ebb Velocities: Plan-Minus-Base Differences

Plan-Minus-Base Differences: Summary Statistics (From Harmonic Analysis)

CLASS INTERVAL	TEST 1 ***			TEST 2 ***			TEST 3 ***			TEST 4 ***			OVERALL ***		
	MAXIMUM EBB		FREQ. RELATIVE FREQ.	MAXIMUM EBB		FREQ. RELATIVE FREQ.	MAXIMUM EBB		FREQ. RELATIVE FREQ.	MAXIMUM EBB		FREQ. RELATIVE FREQ.	MAXIMUM EBB		FREQ. RELATIVE FREQ.
	MAXIMUM	EBB	FREQ.	MAXIMUM	EBB	FREQ.	MAXIMUM	EBB	FREQ.	MAXIMUM	EBB	FREQ.	MAXIMUM	EBB	FREQ.
GREATER THAN 0.8 FPS	2	0.024	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	2	0.005	
0.7 < DIFF. < 0.8 FPS	0	0.000	1	0.011	1	0.011	0	0.000	0	0.000	0	0.000	2	0.006	
0.6 < DIFF. < 0.7 FPS	2	0.024	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	2	0.006	
0.5 < DIFF. < 0.6 FPS	3	0.035	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	3	0.009	
0.4 < DIFF. < 0.5 FPS	0	0.000	5	0.057	0	0.000	0	0.000	0	0.000	0	0.000	5	0.014	
0.3 < DIFF. < 0.4 FPS	5	0.059	6	0.068	1	0.011	1	0.011	1	0.011	1	0.011	13	0.037	
0.2 < DIFF. < 0.3 FPS	4	0.047	6	0.058	5	0.057	0	0.000	0	0.000	0	0.000	15	0.043	
0.1 < DIFF. < 0.2 FPS	4	0.047	11	0.125	11	0.125	2	0.023	2	0.023	28	0.080			
0.0 < DIFF. < 0.1 FPS	8	0.094	8	0.091	9	0.102	4	0.045	29	0.083					
-0.1 < DIFF. < 0.0 FPS	12	0.141	12	0.136	9	0.102	16	0.182	49	0.140					
-0.2 < DIFF. < -0.1 FPS	17	0.200	15	0.170	8	0.091	16	0.182	56	0.160					
-0.3 < DIFF. < -0.2 FPS	4	0.047	9	0.102	12	0.136	16	0.182	41	0.117					
-0.4 < DIFF. < -0.3 FPS	12	0.141	5	0.057	12	0.136	8	0.091	37	0.105					
-0.5 < DIFF. < -0.4 FPS	5	0.059	6	0.068	9	0.091	9	0.091	27	0.077					
-0.6 < DIFF. < -0.5 FPS	1	0.012	1	0.011	6	0.068	10	0.114	18	0.052					
-0.7 < DIFF. < -0.6 FPS	1	0.012	1	0.011	3	0.054	3	0.034	8	0.023					
-0.8 < DIFF. < -0.7 FPS	2	0.024	0	0.000	1	0.011	2	0.023	5	0.014					
LESS. THAN -0.8 FPS	3	0.035	2	0.023	2	0.023	2	0.023	9	0.026					
NUMBER IN SAMPLE	95		88		88		88		349						
MEAN DIFFERENCE (FPS)	-0.08		-0.05		-0.18		-0.27		-0.15						
STANDARD DEVIATION (FPS)	0.38		0.30		0.30		0.24		0.32						

(Sheet 10 of 10)

Table I3A
Flow Predominance (Percent of Flow in Ebb Direction)

STATION	DEPTH FT	TEST 1 *****			TEST 2 *****			TEST 3 *****			TEST 4 *****		
		FLOW PREDOMINANCE		DIFF %									
		BASE %	PLAN %		BASE %	PLAN %		BASE %	PLAN %		BASE %	PLAN %	
CB0001	4	79.4	74.1	-5.2	85.4	82.4	-3.0	76.8	72.1	-4.6	90.6	74.1	-16.5
CB0001	18	70.7	72.4	1.7	67.5	67.8	0.3	68.7	65.0	-3.8	69.5	65.0	-4.5
CB0001	32	71.8	69.1	-2.7	53.2	59.7	6.5	69.5	67.5	-2.0	65.5	53.3	-12.3
CB0002	4	76.4	77.5	1.1	88.1	54.6	-33.4	64.4	60.2	-4.2	71.6	76.6	5.1
CB0002	20	60.9	73.1	12.2	44.2	35.1	-9.1	48.5	49.8	1.4	48.6	45.9	-2.7
CB0002	35	41.0	38.2	-2.9	39.0	29.0	-10.1	43.0	44.0	1.0	37.5	34.4	-3.2
CB0002	54	43.0	39.5	-3.5	38.4	37.4	-0.9	40.7	44.3	3.6	37.9	37.2	-0.7
CB0002	71	41.4	42.5	1.2	37.3	35.6	-1.7	47.8	48.6	0.9	38.4	33.7	-3.3
CB0004	4	73.8	72.6	-1.2	76.5	85.7	9.2	58.0	60.5	2.5	79.0	80.0	1.0
CB0004	16	60.9	60.2	-0.8	49.9	54.7	4.9	50.3	55.0	4.7	52.8	52.1	-0.7
CB0004	28	41.0	38.0	-3.0	47.1	47.2	0.1	50.0	52.4	2.4	44.2	40.9	-3.3
CB0006	4	53.7	67.5	13.8	79.2	83.0	3.8	61.1	63.3	2.2	69.0	66.6	-2.4
CB0006	15	56.5	59.6	3.0	56.7	56.3	-0.3	62.1	58.7	-3.4	54.8	49.5	-5.3
CB0008	4	67.2	67.2	0.0	75.4	78.8	3.4	64.3	63.0	-1.3	55.6	56.5	1.0
CB0008	24	58.1	58.9	0.8	47.4	58.7	11.3	58.2	56.5	-1.7	58.6	53.5	-5.2
CB0008	43	44.3	54.3	10.0	34.3	32.4	-2.0	53.5	50.2	-3.3	45.7	48.7	3.0
CB0009	4	57.7	58.6	0.9	58.7	50.4	-0.3	57.5	53.4	-4.1	56.9	57.0	0.0
CB0009	16	56.7	55.7	-1.0	50.1	50.9	0.7	53.6	50.7	-2.8	50.0	50.4	0.3
CB0101	4	65.3	67.0	1.7	67.8	73.2	5.4	60.2	58.3	-1.9	51.7	52.6	0.9
CB0101	13	58.7	60.7	2.0	60.9	57.7	-3.2	58.5	60.3	1.9	53.4	52.8	-0.6
CB0103	4	62.2	63.9	1.7	76.3	80.5	4.2	60.3	62.1	1.8	71.6	74.1	2.5
CB0103	14	59.7	60.9	1.2	76.5	80.5	4.1	53.8	55.3	1.5	68.9	69.0	0.1
CB0103	24	57.9	58.4	0.4	56.7	68.1	11.4	54.7	55.2	0.5	47.4	51.8	4.5
CB0105	4	54.6	54.0	-0.6	68.4	55.1	-13.3	50.7	50.7	-0.0	55.0	51.3	-3.7
CB0105	20	40.3	41.3	1.0	58.3	22.9	-35.4	42.8	44.1	1.2	34.1	31.5	-2.5
CB0105	37	35.0	27.0	-8.0	28.8	25.8	-3.0	32.7	30.7	-2.0	33.9	34.1	0.2
CB0107	4	62.1	61.5	-0.6	66.3	64.6	-1.7	55.2	56.0	0.7	56.2	48.6	-7.6
CB0107	15	47.5	45.1	-2.4	50.7	50.6	-0.1	40.3	45.6	5.3	46.3	43.0	-3.2
CB0107	27	30.2	29.6	-0.6	36.8	33.2	-3.6	37.7	35.8	-1.9	31.9	28.8	-3.1
CE0109	4	72.4	74.5	2.1	80.4	80.9	0.5	61.1	77.3	16.2	53.6	59.4	-4.2
CE0109	39	27.5	36.7	9.2	37.0	42.1	5.2	33.1	30.8	-2.3	44.1	41.2	-2.8
CE0109	75	8.6	10.7	2.1	61.9	56.0	-5.9	0.0	0.0	0.0	42.2	59.9	18.7

(Continued)

(Sheet 1 of 4)

Table 13A (Continued)

STATION	DEPTH FT	TEST 1 *****			TEST 2 *****			TEST 3 *****			TEST 4 *****				
		FLOW	PREDOMINANCE	BASE	PLAN	DIFF	FLOW	PREDOMINANCE	BASE	PLAN	DIFF	FLOW	PREDOMINANCE	BASE	PLAN
	%	%	%	%	%	%		%	%	%	%		%	%	%
CB0110	4	65.4	63.4	4.0	65.8	71.9	6.1	65.8	67.1	2.1	62.6	67.9	5.3		
CB0110	15	63.2	64.6	1.4	48.7	58.6	10.0	62.5	61.2	-1.3	52.9	54.3	1.4		
AC0002	4	96.5	99.8	3.3	76.5	91.2	14.7	95.2	95.5	0.3	80.1	62.8	-17.3		
AC0002	27	42.1	31.0	-11.1	33.1	28.0	-5.1	40.4	38.7	-1.7	31.1	27.0	-4.0		
AC0002	49	25.7	27.3	1.6	22.5	30.4	8.0	29.9	32.5	2.7	33.3	24.4	-8.9		
AC0002	54	27.3	27.3	0.0	27.3	33.3	***	33.3	34.5	***	31.7	31.7	0.0		
TS0003	4	63.5	65.0	1.5	73.7	72.0	-1.7	62.6	59.3	-3.3	66.8	61.8	-5.0		
TS0003	26	42.3	41.5	-0.8	35.7	37.9	4.2	44.3	37.9	-6.4	39.4	35.9	-3.5		
TS0003	46	38.3	33.3	-5.0	27.8	28.5	0.8	40.7	38.9	-1.8	41.8	22.0	-19.8		
TS0003	51	36.1	36.1	0.0	27.8	28.6	0.8	40.7	38.9	-1.8	41.8	22.0	-19.8		
TS0005	4	77.1	78.3	1.2	96.3	97.1	0.9	70.1	69.8	-0.3	85.1	77.2	-7.9		
TS0005	27	58.2	56.8	-1.4	56.3	41.7	-14.6	53.6	58.7	5.1	51.1	15.8	-35.3		
TS0005	50	0.0	0.0	0.0	1.5	3.8	2.3	0.0	4.9	4.9	0.0	0.0	0.0		
TS0005	55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
YS0001	4	48.8	52.5	3.7	61.0	67.3	6.4	46.1	41.2	-4.8	50.8	47.7	-3.1		
YS0001	25	34.0	37.2	3.2	38.8	20.3	-18.5	38.0	33.6	-4.4	24.9	24.9	0.0		
YS0001	45	23.2	24.3	1.1	17.4	21.0	3.6	35.5	29.1	-6.4	18.3	19.7	1.4		
JG0101	4	55.2	64.4	9.2	70.1	73.7	3.6	52.0	48.9	-3.1	59.6	59.3	-0.3		
JG0101	11	57.6	62.1	4.5	63.1	68.7	5.6	48.3	51.3	3.0	58.0	59.2	1.3		
JG0102	4	62.8	62.3	-0.4	68.2	73.8	5.6	62.2	59.5	-2.6	65.3	64.2	-1.1		
JG0102	26	62.1	62.4	0.3	52.6	56.4	3.8	61.0	60.2	-0.8	59.4	59.4	0.0		
JG0102	48	57.2	54.5	-2.7	42.0	34.6	-7.4	56.4	56.7	0.3	60.2	62.7	2.5		
JG0103	4	65.9	67.2	1.2	68.8	71.7	2.8	57.7	61.6	3.8	66.4	72.2	5.8		
JG0103	22	64.7	60.7	-4.0	57.1	50.8	-6.3	54.5	52.5	-2.0	60.8	59.9	-0.9		
JG0103	44	52.2	54.8	2.6	33.3	34.0	0.7	51.8	48.3	-3.5	43.3	39.3	-4.0		
JG0103	65	38.2	37.8	-0.4	24.9	24.7	-0.2	38.0	37.6	-0.4	38.8	25.1	-3.7		
JG0103	83	59.4	22.7	-35.7	16.1	19.9	3.8	15.3	23.7	8.4	26.4	12.0	-14.4		
JG0311	4	64.0	60.0	-4.0	64.1	63.3	-0.8	68.3	60.8	-7.5	53.8	51.9	-11.9		
JG0311	11	64.1	63.5	-0.6	66.4	60.0	-6.4	60.0	59.6	-0.4	59.0	53.1	-5.9		
JG0302	4	58.3	60.5	2.2	63.2	60.2	-2.9	59.8	56.9	-2.9	56.9	42.7	-14.2		
JG0302	16	60.7	59.2	-1.5	55.9	58.3	2.3	55.1	54.3	-1.8	46.4	49.2	2.8		
JG0302	27	58.7	60.1	1.4	76.3	80.7	4.3	52.2	55.0	2.9	45.6	62.5	17.0		

(Continued)

Table 13A (Concluded)

STATION	DEPTH FT	TEST 1 *****				TEST 2 *****				TEST 3 *****				TEST 4 *****			
		FLOW BASE	PREDOMINANCE PLAN	DIFF %	%	FLOW BASE	PREDOMINANCE PLAN	DIFF %	%	FLOW BASE	PREDOMINANCE PLAN	DIFF %	%	FLOW BASE	PREDOMINANCE PLAN	DIFF %	%
JG0321	4	64.6	66.1	1.4	66.3	66.6	0.3	63.6	63.3	-0.2	62.5	60.3	-2.2				
JN0322	4	50.6	60.2	9.6	53.1	62.7	9.5	54.2	49.5	-4.6	58.5	57.1	-1.5				
JN0202	12	55.4	51.7	-3.7	48.0	53.2	5.2	48.7	48.6	-0.1	47.3	48.4	1.2				
JN0203	4	71.0	72.4	1.5	80.9	81.4	0.5	69.6	71.9	2.3	78.3	78.0	-0.3				
JN0203	20	59.0	63.8	4.9	56.2	61.4	5.2	53.5	58.4	4.9	58.9	60.3	1.4				
JN0204	4	65.6	79.1	13.5	77.0	74.9	-2.1	67.9	72.4	4.4	76.1	77.2	1.1				
JN0204	26	49.6	47.8	-1.8	43.7	43.3	-0.4	52.7	48.8	-3.9	47.4	48.2	0.8				
JN0204	48	36.3	29.8	-6.5	5.1	4.7	-1.4	45.8	42.7	-3.1	17.7	11.0	-6.7				
JN0204	55	16.1	*****	*****	3.8	*****	*****	42.5	*****	*****	7.5	*****	*****				
EH0204	4	69.5	67.3	-2.2	63.7	67.8	-1.0	60.7	55.3	-4.4	68.2	70.1	1.9				
EH0202	25	55.8	47.4	-8.4	51.7	27.2	6.5	52.7	51.8	-0.9	40.4	27.7	-12.7				
EH0202	46	43.6	70.5	27.0	61.7	55.9	-5.9	41.6	57.2	15.6	32.2	14.2	-18.0				
EH0202	55	*****	41.4	*****	*****	66.2	*****	46.9	*****	*****	28.0	*****	*****				
EH0203	4	68.5	69.7	1.3	76.9	68.0	-9.8	56.2	66.0	9.7	71.6	75.6	4.0				
EH0203	22	50.6	38.0	-12.6	17.9	18.5	0.7	51.8	46.5	-5.3	41.9	47.4	5.5				
EH0203	40	31.1	19.8	-11.3	34.7	69.3	34.5	45.2	31.2	-14.0	32.3	38.7	6.4				
EH0501	4	67.0	69.5	2.5	54.9	57.2	2.2	74.8	40.5	-34.2	66.5	85.8	19.3				
EH0501	22	45.9	59.5	18.6	63.1	49.1	-15.0	50.6	65.1	14.5	36.8	14.4	-22.4				
EH0501	39	40.0	67.6	27.5	79.6	76.1	-3.5	39.5	29.1	-6.4	50.4	65.3	14.9				
EH0501	45	*****	52.2	*****	71.5	*****	*****	29.6	*****	*****	58.8	*****	*****				
EH0701	4	64.3	47.7	-16.7	94.9	61.9	-14.8	64.4	50.7	-17.7	72.8	62.4	-11.5				
EH0701	19	60.1	58.3	-1.8	77.2	67.0	-10.2	52.7	55.7	3.0	66.8	69.0	2.2				
EH0701	35	60.1	52.7	-7.4	46.2	62.0	15.8	52.0	55.8	3.8	55.3	37.9	-17.5				
EH0701	40	*****	33.1	*****	64.0	*****	*****	53.1	*****	*****	35.0	*****	*****				
EH0901	4	86.2	77.9	-8.2	83.9	88.9	-3.0	77.9	71.6	-6.3	74.6	88.4	13.8				
EH0901	19	73.9	53.7	-19.3	72.3	68.1	-35.7	50.0	41.5	-8.4	54.7	70.6	15.9				
EH0901	35	55.1	52.7	-2.4	46.2	62.0	15.8	52.0	55.8	3.8	55.3	37.9	-17.5				
EH0901	40	*****	33.1	*****	64.0	*****	*****	53.1	*****	*****	35.0	*****	*****				
EH0901	45	*****	52.2	*****	71.5	*****	*****	53.1	*****	*****	58.8	*****	*****				
EH0901	51	40.1	40.1	0.0	40.1	40.1	0.0	40.1	40.1	0.0	40.1	40.1	0.0				
EH0901	54	34.1	34.1	0.0	34.1	34.1	0.0	34.1	34.1	0.0	34.1	34.1	0.0				
EH0901	55	31.1	31.1	0.0	31.1	31.1	0.0	31.1	31.1	0.0	31.1	31.1	0.0				
EH0901	56	29.1	29.1	0.0	29.1	29.1	0.0	29.1	29.1	0.0	29.1	29.1	0.0				
EH0901	57	27.1	27.1	0.0	27.1	27.1	0.0	27.1	27.1	0.0	27.1	27.1	0.0				
EH0901	58	25.1	25.1	0.0	25.1	25.1	0.0	25.1	25.1	0.0	25.1	25.1	0.0				
EH0901	59	23.1	23.1	0.0	23.1	23.1	0.0	23.1	23.1	0.0	23.1	23.1	0.0				
EH0901	60	21.1	21.1	0.0	21.1	21.1	0.0	21.1	21.1	0.0	21.1	21.1	0.0				
EH0901	61	19.1	19.1	0.0	19.1	19.1	0.0	19.1	19.1	0.0	19.1	19.1	0.0				
EH0901	62	17.1	17.1	0.0	17.1	17.1	0.0	17.1	17.1	0.0	17.1	17.1	0.0				
EH0901	63	15.1	15.1	0.0	15.1	15.1	0.0	15.1	15.1	0.0	15.1	15.1	0.0				
EH0901	64	13.1	13.1	0.0	13.1	13.1	0.0	13.1	13.1	0.0	13.1	13.1	0.0				
EH0901	65	11.1	11.1	0.0	11.1	11.1	0.0	11.1	11.1	0.0	11.1	11.1	0.0				
EH0901	66	9.1	9.1	0.0	9.1	9.1	0.0	9.1	9.1	0.0	9.1	9.1	0.0				
EH0901	67	7.1	7.1	0.0	7.1	7.1	0.0	7.1	7.1	0.0	7.1	7.1	0.0				
EH0901	68	5.1	5.1	0.0	5.1	5.1	0.0	5.1	5.1	0.0	5.1	5.1	0.0				
EH0901	69	3.1	3.1	0.0	3.1	3.1	0.0	3.1	3.1	0.0	3.1	3.1	0.0				
EH0901	70	1.1	1.1	0.0	1.1	1.1	0.0	1.1	1.1	0.0	1.1	1.1	0.0				
EH0901	71	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	72	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	73	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	74	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	75	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	76	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	77	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	78	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	79	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	80	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	81	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	82	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	83	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	84	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	85	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	86	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	87	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	88	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	89	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	90	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	91	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	92	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	93	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	94	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	95	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	96	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	97	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	98	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	99	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0				
EH0901	100	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0			</	

Table 13B
Flow Predominance (Percent of Flow in Ebb Direction)
Plan-Minus-Base Summary Statistics

CLASS INTERVAL	TEST 1 *** FREQ. RELATIVE FREQ.		TEST 2 *** FREQ. RELATIVE FREQ.		TEST 3 *** FREQ. RELATIVE FREQ.		TEST 4 *** FREQ. RELATIVE FREQ.		*** OVERALL *** FREQ. RELATIVE FREQ.	
	GREATER THAN 40%	0	0.000	1	0.011	0	0.000	0	0.000	
30% < DIFF < 40%	0	0.000	2	0.023	0	0.000	0	0.000	2	0.006
20% < DIFF < 30%	2	0.023	0	0.000	0	0.000	0	0.000	2	0.006
15% < DIFF < 20%	1	0.011	1	0.011	2	0.023	4	0.045	8	0.023
10% < DIFF < 15%	4	0.045	4	0.045	1	0.011	3	0.034	12	0.034
5% < DIFF < 10%	5	0.057	14	0.159	4	0.045	6	0.068	29	0.082
0% < DIFF < 5%	36	0.103	27	0.307	27	0.307	24	0.273	114	0.324
-5% < DIFF < 0%	27	0.307	21	0.239	43	0.489	28	0.318	119	0.338
-10% < DIFF < -5%	7	0.080	8	0.091	7	0.080	9	0.102	31	0.088
-15% < DIFF < -10%	3	0.034	6	0.050	3	0.034	7	0.060	19	0.054
-20% < DIFF < -15%	2	0.023	1	0.011	0	0.000	5	0.057	8	0.023
-30% < DIFF < -20%	0	0.000	0	0.000	0	0.000	1	0.011	1	0.003
-40% < DIFF < -30%	1	0.011	2	0.023	1	0.011	1	0.011	5	0.014
LESS THAN -40%	0	0.000	1	0.011	0	0.000	0	0.000	1	0.003
<hr/>										
NUTSER IN SAMPLE	88		88						88	
MEAN DIFFERENCE (%)	0.37		0.22						-1.92	
STANDARD DEVIATION (%)	8.19		12.46						6.31	
									8.91	

(Sheet 4 of 4)

Table 14
 SALINITY STATION LOCATIONS
DYNAMIC HYDROGRAPH TESTS

Station	Body of Water	Sampling Depths ft below msl	Latitude	Longitude
AC0001	Atlantic Channel	4,14,24,50	35°49'54"	75°48'52"
AC0002	Atlantic Channel	4,14,24,50,57*	36°54'06"	75°54'33"
AC0003	Atlantic Channel	4,14,24,50,57*	36°55'10"	75°56'12"
BG0101	Back River (Virginia)	3,10	37°06'36"	76°17'30"
CB0001	Chesapeake Bay	5,13,23,33	36°56'12"	76°00'18"
CB0002	Chesapeake Bay	4,12,22,32,68	36°57'30"	76°00'05"
CB0003	Chesapeake Bay	4,22,32	36°58'48"	75°59'43"
CB0004	Chesapeake Bay	4,22,30	37°00'06"	75°59'30"
CB0005	Chesapeake Bay	4,12,17	37°01'12"	75°59'18"
CB0006	Chesapeake Bay	5,12	37°02'00"	75°59'06"
CB0007	Chesapeake Bay	5,13,18	37°02'54"	75°58'54"
CB0008	Chesapeake Bay	5,23,43	37°03'18"	75°58'48"
CB0009	Chesapeake Bay	4,16	37°04'37"	75°58'36"
CB0101	Chesapeake Bay	5,15	37°05'38"	76°14'43"
CB0102	Chesapeake Bay	4,12,18	37°06'37"	76°07'18"
CB0103	Chesapeake Bay	5,15,28	37°07'05"	76°12'15"
CB0104	Chesapeake Bay	4,13,30	37°07'37"	76°11'07"
CB0105	Chesapeake Bay	4,23,37	37°08'36"	76°08'59"
CB0106	Chesapeake Bay	4,12,22	37°09'44"	76°06'33"
CB0107	Chesapeake Bay	4,12,27	37°10'36"	76°01'37"
CB0108	Chesapeake Bay	4,14,28	37°11'12"	76°03'03"
CB0109	Chesapeake Bay	4,12,22,42,72	37°11'48"	76°02'01"
CB0110	Chesapeake Bay	4,17	37°12'03"	76°01'32"
CB0202	Chesapeake Bay	4,12,27	37°30'16"	76°12'48"
CB0204	Chesapeake Bay	4,12,32	37°30'08"	76°08'12"
CB0206	Chesapeake Bay	4,22,42	37°30'15"	76°04'42"
CB0208	Chesapeake Bay	4,32,52	37°30'21"	76°02'26"
CB0210	Chesapeake Bay	3,11,26	37°30'28"	75°59'38"
CB0301	Chesapeake Bay	4,22,35	37°54'02"	76°11'42"
CB0303	Chesapeake Bay	4,22,62	37°54'18"	76°10'08"
CB0306	Chesapeake Bay	4,22,37	37°54'46"	76°07'16"
CB0310	Chesapeake Bay	3,1,57	37°56'30"	75°56'30"
CB0401	Chesapeake Bay	4,22,32	38°23'14"	76°22'16"
CB0404	Chesapeake Bay	4,42,92	38°21'20"	76°20'13"
CB0407	Chesapeake Bay	4,16	38°23'29"	76°18'15"

(Continued)

* Additional depths sampled during plan test only.

(Sheet 1 of 6)

Table 14 (Continued)

Station	Body of Water	Sampling Depths (ft below msl)	Latitude	Longitude
CB0502	Chesapeake Bay	4,22,32	38°50'32"	76°26'12"
CB0505	Chesapeake Bay	4,52,102	38°50'35"	76°23'50"
CB0611	Chesapeake Bay	4,28,53	39°08'03"	76°24'06"
CB0604	Chesapeake Bay	4,22,37	39°08'20"	76°19'23"
CB0703	Chesapeake Bay	4,12,29	39°19'57"	76°12'02"
CB0705	Chesapeake Bay	3,23,43	39°19'22"	76°11'24"
CC0001	Cape Henry Channel	4,23,52	36°59'05"	76°00'11"
CC0002	Cape Henry Channel	4,24,47	36°59'48"	76°00'54"
CG0101	Choptank River	4,22,62	38°38'10"	76°09'36"
C00101	Chickahominy River	4,20	36°16'13"	76°52'47"
C00201	Chickahominy River	4,10	36°18'42"	76°52'42"
EE0101	E. Br. Elizabeth River	4,16,28	36°50'27"	76°16'56"
EE0201	E. Br. Elizabeth River	4,14,24	36°50'24"	76°16'00"
EE0301	E. Br. Elizabeth River	4,14,24	36°50'13"	76°14'48"
EH0101	Elizabeth River	4,12	36°55'30"	76°20'08"
EH0102	Elizabeth River	4,14,24,48,58*	36°55'30"	76°20'21"
EH0103	Elizabeth River	4,14	36°55'30"	76°20'33"
EH0201	Elizabeth River	4	36°53'09"	76°19'53"
EH0202	Elizabeth River	4,14,24,48,58*	36°53'15"	76°20'04"
EH0203	Elizabeth River	4,24,43	36°53'14"	76°20'16"
EH0301	Elizabeth River	4,14,24,48	36°52'25"	76°19'59"
EH0302	Elizabeth River	4,14,24	36°52'23"	76°20'12"
EH0401	Elizabeth River	4,14,24,44,48*	36°51'31"	76°18'50"
EH0501	Elizabeth River	4,14,24,42,48*	36°50'34"	76°17'41"
EH0601	Elizabeth River	4,14,24,42,48*	36°48'50"	76°17'28"
EH0701	Elizabeth River	4,14,24,36,43*	36°47'05"	76°18'13"
EH0801	Elizabeth River	4,14,24,36,41*	36°46'36"	76°17'45"
EH0901	Elizabeth River	4,14,24,36	36°45'18"	76°17'44"
EH1001	Elizabeth River	3,13	36°43'53"	76°16'49"

(Continued)

(Sheet 2 of 6)

Table 14 (Continued)

Station	Body of Water	Sampling Depths ft below msl	Latitude	Longitude
JG0101	James River	3,13	36°58'54"	76°17'36"
JG0102	James River	3,23,43	36°59'36"	76°17'54"
JG0103	James River	3,13,23,43,72	37°00'00"	76°18'12"
JG0211	James River	4,14	36°58'17"	76°28'20"
JG0201	James River	3,12	36°58'48"	76°27'54"
JG0202	James River	3,12,22	36°58'54"	76°27'12"
JG0203	James River	3,23,43	36°59'12"	76°26'54"
JG0311	James River	4,14	37°03'06"	76°36'16"
JG0301	James River	3,12,18	37°02'54"	76°35'54"
JG0302	James River	4,13,20,30	37°03'30"	76°35'36"
JG0321	James River	4	37°04'11"	76°36'15"
JG0401	James River	2,19	37°11'54"	76°40'18"
JG0402	James River	4,13,28	37°12'30"	76°39'12"
JG0501	James River	3,7,2	37°12'54"	76°48'00"
JG0502	James River	3,20,39	37°13'06"	76°47'36"
JG0601	James River	3,13,22	37°14'06"	76°56'48"
JG0701	James River	4,14,29	37°17'06"	77°02'36"
JG0801	James River	5,15,25	37°18'06"	77°08'42"
JG0901	James River	4,16,29	37°19'06"	77°16'21"
JG1001	James River	4,13,24	37°22'48"	77°20'18"
JN0101	James River	4,12,20	36°58'06"	76°19'49"
JN0102	James River	4,14,24,44,57*	36°58'17"	76°20'03"
JN0103	James River	4,14,24,34,58	36°58'30"	76°20'16"
JN0104	James River	4,14,24,44	36°58'52"	76°20'41"
JN0105	James River	4,12	36°59'33"	76°21'25"
JN0201	James River	4,12	36°55'09"	76°25'56"
JN0202	James River	4,14	36°55'23"	76°25'46"
JN0203	James River	4,14,23	36°56'24"	76°25'22"
JN0204	James River	4,14,24,50,58*	36°57'04"	76°25'07"
JN0205	James River	4,14,22	36°57'28"	76°24'41"
JN0301	James River	4	37°00'33"	76°32'44"
JN0302	James River	4,18	37°01'17"	76°31'55"
JN0303	James River	4,18,32	37°01'43"	76°31'26"
JN0304	James River	4	37°02'33"	76°30'33"

(Continued)

(Sheet 3 of 6)

Table 14 (Continued)

Station	Body of Water	Sampling Depths ft below msl	Latitude	Longitude
JN0401	James River	4,14,24	37° 04' 21"	76° 39' 53"
JN0501	James River	4,14	37° 07' 29"	76° 39' 05"
JN0502	James River	4,17,31	37° 07' 33"	76° 38' 32"
JN0601	James River	4,10	37° 10' 30"	76° 42' 32"
JN0602	James River	4,10	37° 10' 50"	76° 43' 10"
JN0603	James River	4,14,28	37° 11' 15"	76° 43' 53"
JN0701	James River	4	37° 09' 30"	76° 44' 02"
JN0801	James River	4,14,25	37° 12' 55"	76° 52' 41"
JN0802	James River	4,12	37° 13' 28"	76° 52' 42"
JN0803	James River	4,14,24	37° 14' 36"	76° 52' 43"
LF0101	Lafayette River	4	36° 54' 04"	76° 19' 11"
LF0201	Lafayette River	4,16	36° 54' 13"	76° 17' 40"
LF0301	Lafayette River	4,10	36° 53' 16"	76° 16' 42"
LH0001	Lynhaven Bay	4,20	36° 55' 09"	76° 05' 18"
LS0001	Horseshoe Shoal	4,18	36° 57' 26"	76° 12' 37"
LS0002	Horseshoe Shoal	4,14,23	36° 58' 53"	76° 12' 08"
LS0003	Horseshoe Shoal	4,14,24	37° 00' 20"	76° 11' 44"
LS0004	Horseshoe Shoal	4,18	37° 01' 30"	76° 11' 21"
MB0102	Mobjack Bay	3,20	37° 18' 42"	76° 20' 48"
MF0001	Fort McHenry Channel	4,22,52	39° 13' 48"	76° 32' 32"
NG0101	Nanticoke River	4,14,24	38° 14' 50"	75° 55' 39"
NN0001	Newport News Channel	4,14,32,50,58*	36° 57' 35"	76° 21' 15"
NS0101	Nansemond River	4,17	36° 54' 12"	76° 27' 32"
NS0102	Nansemond River	4	36° 54' 23"	76° 28' 16"
NS0201	Nansemond River	4,12,20	36° 53' 18"	76° 29' 17"
NS0301	Nansemond River	4,12,19	36° 52' 03"	76° 30' 37"
NS0401	Nansemond River	4,10	36° 50' 31"	76° 32' 00"
NS0501	Nansemond River	4	36° 49' 11"	76° 32' 22"
PG0101	Patuxent River	3,22,39	38° 18' 43"	76° 25' 17"

(Continued)

(Sheet 4 of 6)

Table 14 (Continued)

Station	Body of Water	Sampling Depths (ft below msl)	Latitude	Longitude
P10101	Piankatank River	4,12,20	37° 31' 54"	76° 18' 24"
P00102	Potomac River	3,22,38	37° 58' 30"	76° 19' 42"
P00103	Potomac River	3,22,40	37° 59' 30"	76° 19' 54"
P00104	Potomac River	3,31,49	38° 00' 52"	76° 20' 00"
P00202	Potomac River	3,22,60	38° 04' 04"	76° 27' 11"
P00301	Potomac River	3,32,57	38° 09' 28"	76° 34' 39"
P00402	Potomac River	4,22,41	38° 12' 08"	76° 45' 42"
P00601	Potomac River	3,22,62	38° 21' 20"	76° 59' 12"
P00802	Potomac River	5,19	38° 21' 38"	77° 14' 59"
PQ0101	Poquesson River	3,10	37° 10' 12"	76° 23' 00"
PR0103	Patapsco River	14,32,48	39° 10' 45"	76° 26' 33"
PR0202	Patapsco River	15,33,50	39° 11' 58"	76° 30' 10"
RG0101	Rappahannock River	3,13,26	37° 34' 54"	76° 17' 30"
RG0102	Rappahannock River	3,20,33	37° 36' 06"	76° 17' 06"
RG0201	Rappahannock River	3,13,26	37° 36' 25"	76° 23' 41"
RG0202	Rappahannock River	3,14,25,52	37° 36' 55"	76° 23' 54"
RG0301	Rappahannock River	3,13,26,59	37° 37' 54"	76° 28' 36"
RG0302	Rappahannock River	3,13,20	37° 38' 42"	76° 28' 12"
RG0501	Rappahannock River	3,13,25	37° 45' 54"	76° 37' 12"
RG0601	Rappahannock River	2,19	37° 48' 36"	76° 42' 36"
RG0701	Rappahannock River	2,19	37° 52' 30"	76° 46' 18"
RS0001	Rappahannock Shoal Ch.	4,24,52	37° 34' 51"	76° 03' 32"
RS0002	Rappahannock Shoal Ch.	4,24,52	37° 37' 00"	76° 05' 48"
RS0003	Rappahannock Shoal Ch.	4,23,52	37° 39' 12"	76° 08' 02"
TS0001	Thimble Shoal Channel	4,14,24,49	36° 56' 49"	76° 00' 11"
TS0002	Thimble Shoal Channel	4,14,24,49,58*	36° 57' 40"	76° 04' 45"
TS0003	Thimble Shoal Channel	4,14,24,49,54*	36° 58' 21"	76° 06' 39"
TS0004	Thimble Shoal Channel	4,14,24,49,58*	36° 59' 47'	76° 11' 53"
TS0005	Thimble Shoal Channel	4,14,24,49,58*	37° 00' 24"	76° 14' 39"

(Continued)

(Sheet 5 of 6)

Table 14 (Concluded)

Station	Body of Water	Sampling Depths ft below msl	Latitude	Longitude
WB0101	W. Br. Elizabeth River	4,14	36°51'34"	76°20'07"
WB0201	W. Br. Elizabeth River	4,16	36°51'14"	76°21'20"
W00101	Willoughby Bay	4,10	36°57'27"	76°16'57"
YG0101	York River	4,24,34	37°14'12"	76°25'00"
YG0102	York River	5,25,54	37°14'30"	76°25'00"
YG0201	York River	4,14,44,59	37°14'18"	76°30'12"
YG0301	York River	3,13	37°19'00"	76°36'24"
YG0302	York River	3,11,27	37°19'18"	76°35'54"
YG0401	York River	3,11	37°22'12"	76°39'00"
YG0402	York River	12,18,25	37°22'24"	76°38'36"
YG0501	York River	4,14,26	37°24'48"	76°41'06"
YG0601	York River	4,14,24	37°29'18"	76°45'24"
YS0001	York Spit Channel	4,24,49	37°02'33"	76°04'31"
YS0002	York Spit Channel	4,22,49	37°06'24"	76°07'16"
YS0003	York Spit Channel	4,22,49	37°11'03"	76°09'18"
YS0004	York Spit Channel	4,22,49	37°14'12"	76°08'08"
YS0005	York Spit Channel	4,24,52	37°17'12"	76°06'59"

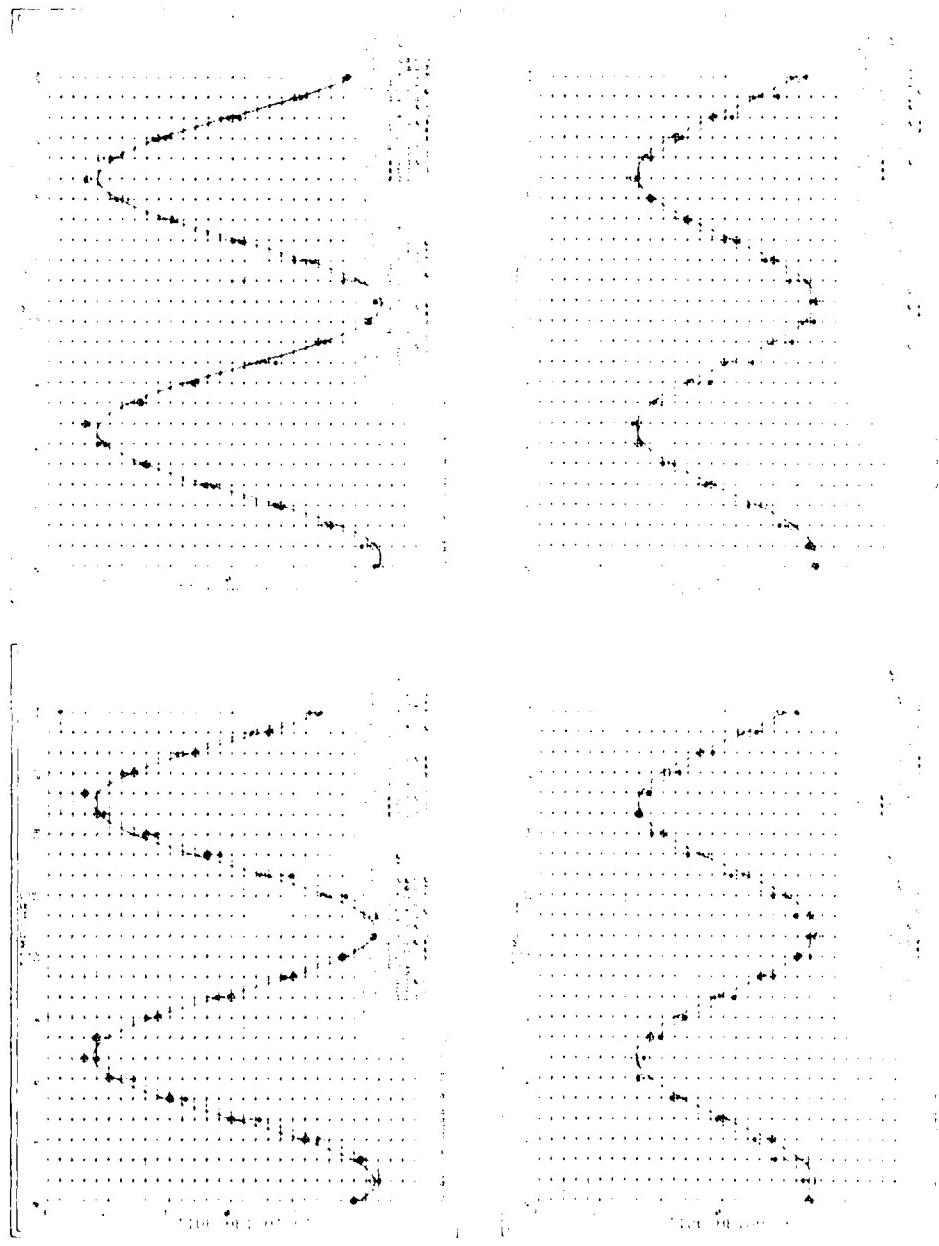


PLATE 1

PLATE 2

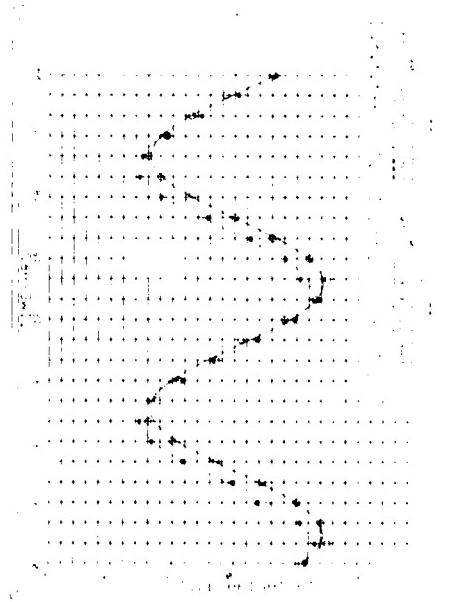
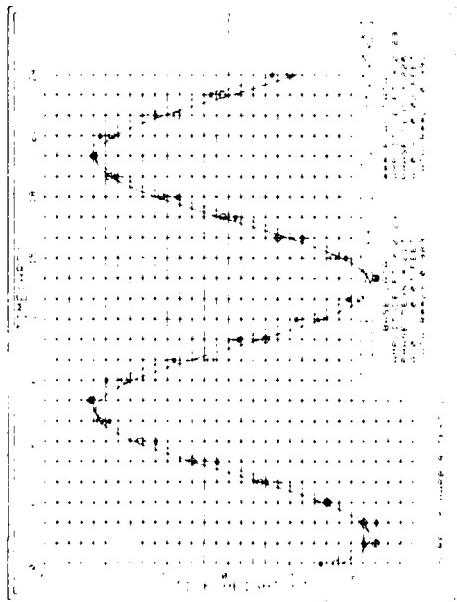
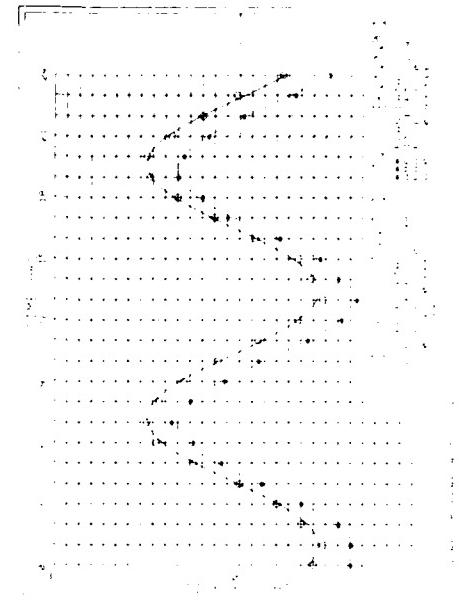
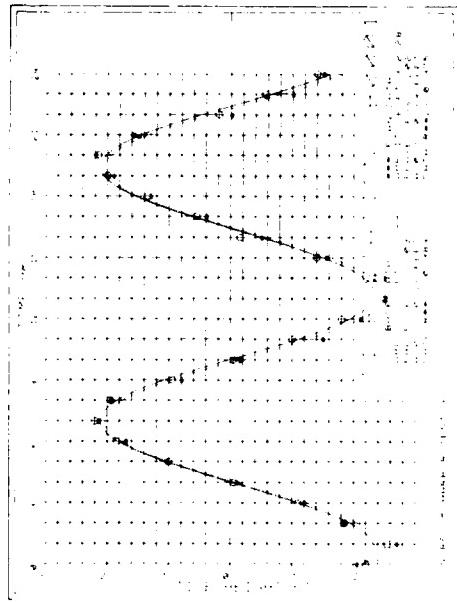


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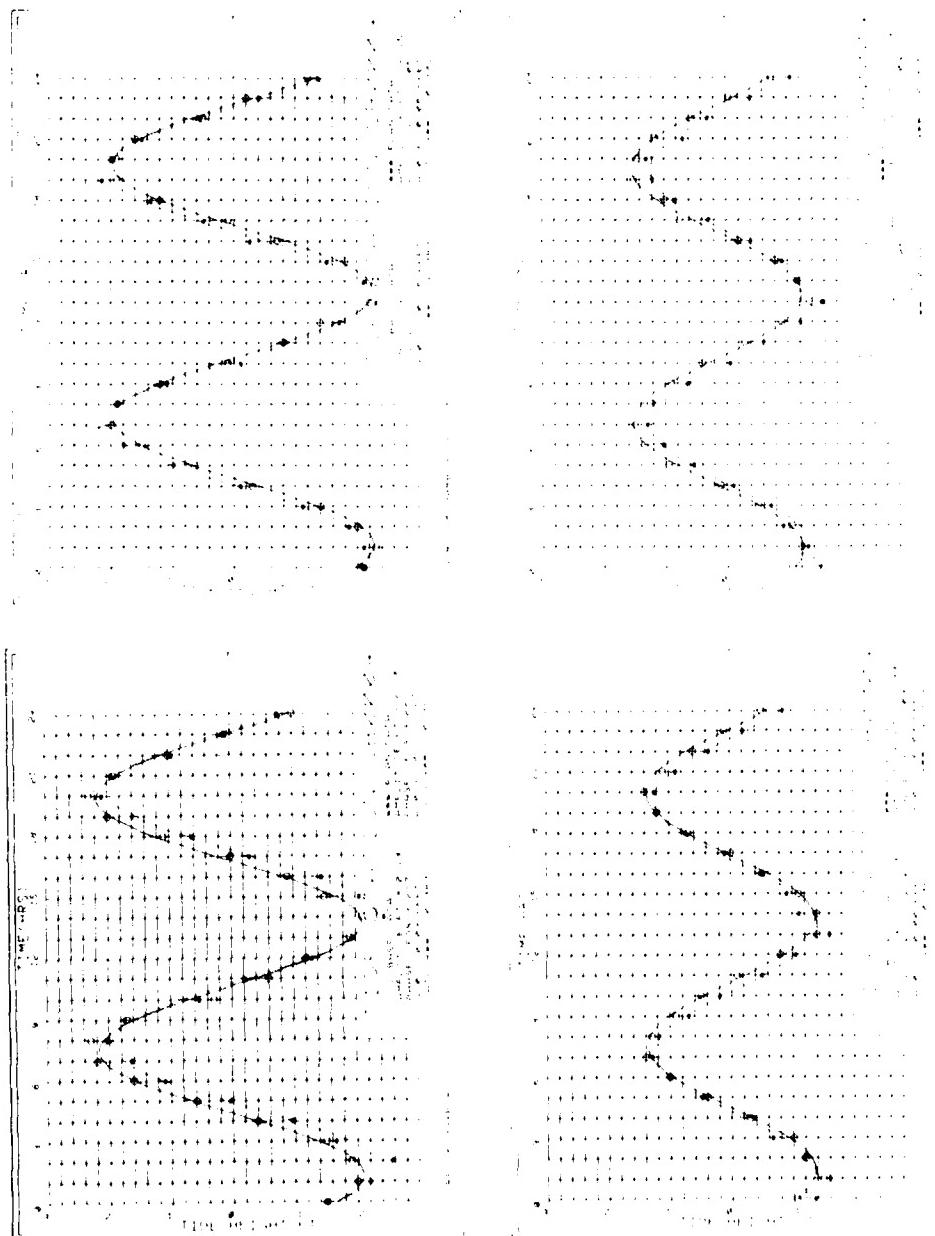


PLATE 4

PLATE 5

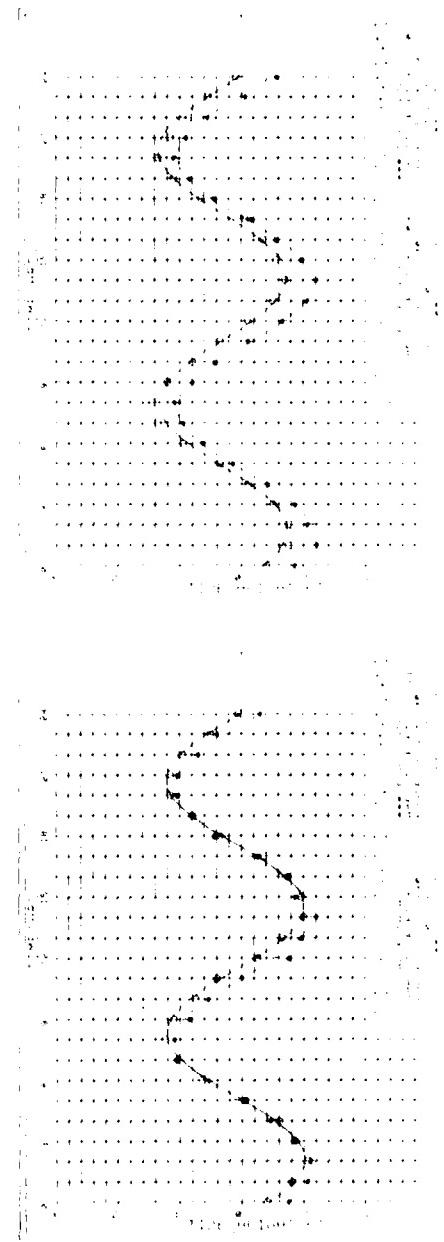
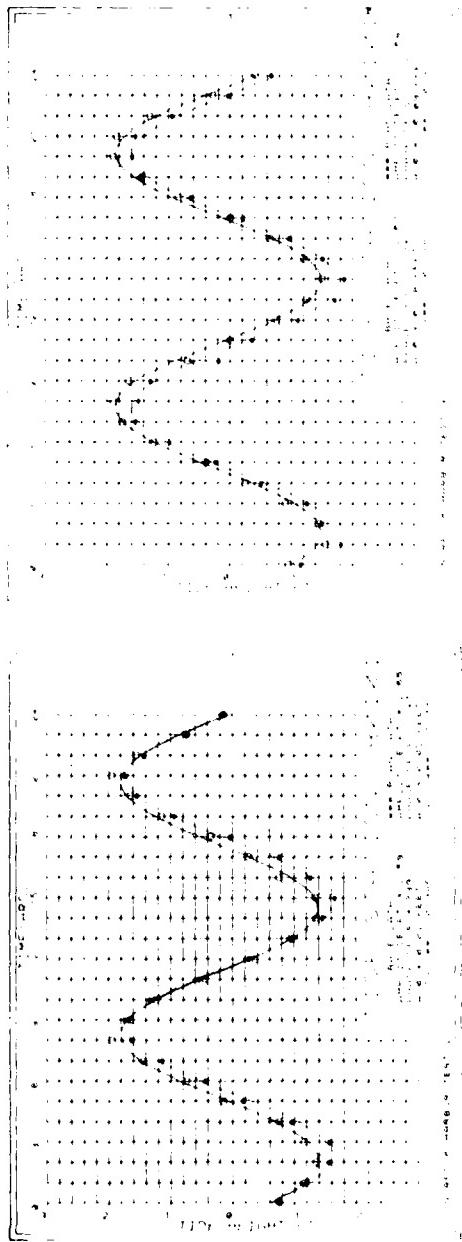


PLATE 6

PLATE 7

PLATE 8

PLATE 10

1. *Leucostoma* sp. (Diptera: Tachinidae) was collected from a female *Thomomys* sp. (Rodentia: Thomomysidae) at 10,000' elevation in the San Juan Mts., Colorado. The fly was found to be a parasite of the rodent. The rodent was captured in a live trap set near a stream bed.

2. *Leucostoma* sp. (Diptera: Tachinidae) was collected from a female *Thomomys* sp. (Rodentia: Thomomysidae) at 10,000' elevation in the San Juan Mts., Colorado. The fly was found to be a parasite of the rodent. The rodent was captured in a live trap set near a stream bed.

3. *Leucostoma* sp. (Diptera: Tachinidae) was collected from a female *Thomomys* sp. (Rodentia: Thomomysidae) at 10,000' elevation in the San Juan Mts., Colorado. The fly was found to be a parasite of the rodent. The rodent was captured in a live trap set near a stream bed.

4. *Leucostoma* sp. (Diptera: Tachinidae) was collected from a female *Thomomys* sp. (Rodentia: Thomomysidae) at 10,000' elevation in the San Juan Mts., Colorado. The fly was found to be a parasite of the rodent. The rodent was captured in a live trap set near a stream bed.

5. *Leucostoma* sp. (Diptera: Tachinidae) was collected from a female *Thomomys* sp. (Rodentia: Thomomysidae) at 10,000' elevation in the San Juan Mts., Colorado. The fly was found to be a parasite of the rodent. The rodent was captured in a live trap set near a stream bed.

6. *Leucostoma* sp. (Diptera: Tachinidae) was collected from a female *Thomomys* sp. (Rodentia: Thomomysidae) at 10,000' elevation in the San Juan Mts., Colorado. The fly was found to be a parasite of the rodent. The rodent was captured in a live trap set near a stream bed.

7. *Leucostoma* sp. (Diptera: Tachinidae) was collected from a female *Thomomys* sp. (Rodentia: Thomomysidae) at 10,000' elevation in the San Juan Mts., Colorado. The fly was found to be a parasite of the rodent. The rodent was captured in a live trap set near a stream bed.

8. *Leucostoma* sp. (Diptera: Tachinidae) was collected from a female *Thomomys* sp. (Rodentia: Thomomysidae) at 10,000' elevation in the San Juan Mts., Colorado. The fly was found to be a parasite of the rodent. The rodent was captured in a live trap set near a stream bed.

9. *Leucostoma* sp. (Diptera: Tachinidae) was collected from a female *Thomomys* sp. (Rodentia: Thomomysidae) at 10,000' elevation in the San Juan Mts., Colorado. The fly was found to be a parasite of the rodent. The rodent was captured in a live trap set near a stream bed.

10. *Leucostoma* sp. (Diptera: Tachinidae) was collected from a female *Thomomys* sp. (Rodentia: Thomomysidae) at 10,000' elevation in the San Juan Mts., Colorado. The fly was found to be a parasite of the rodent. The rodent was captured in a live trap set near a stream bed.

PLATE 11

PLATE 12

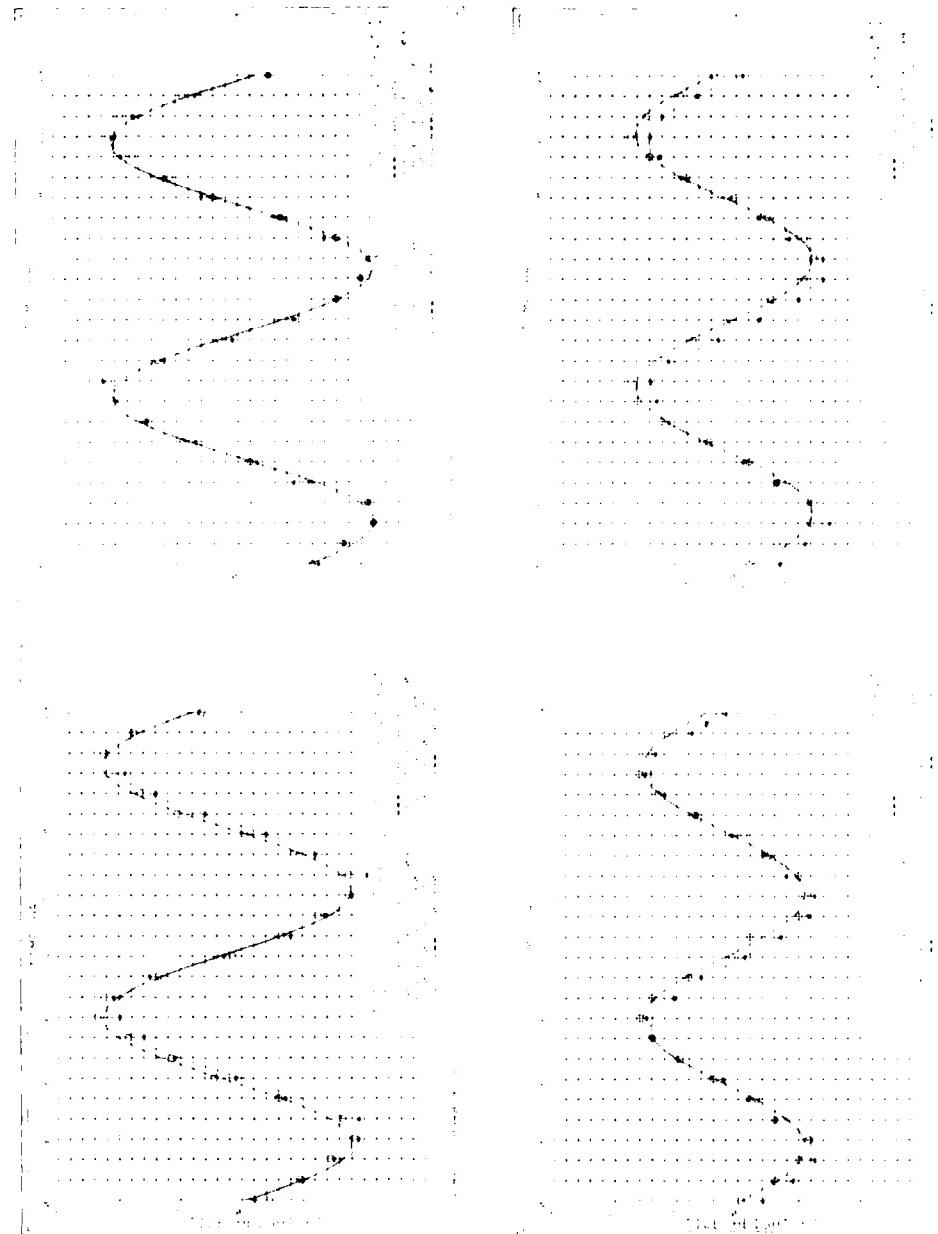


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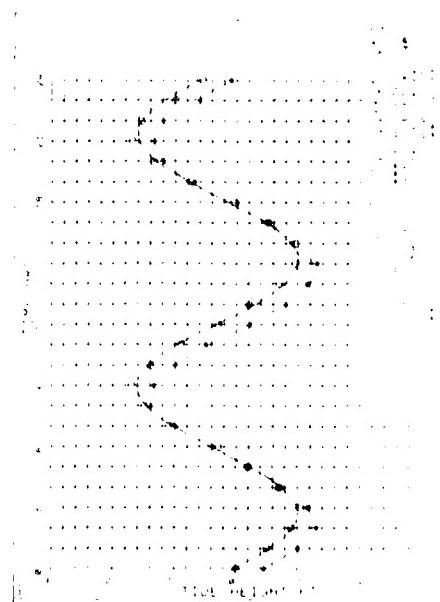
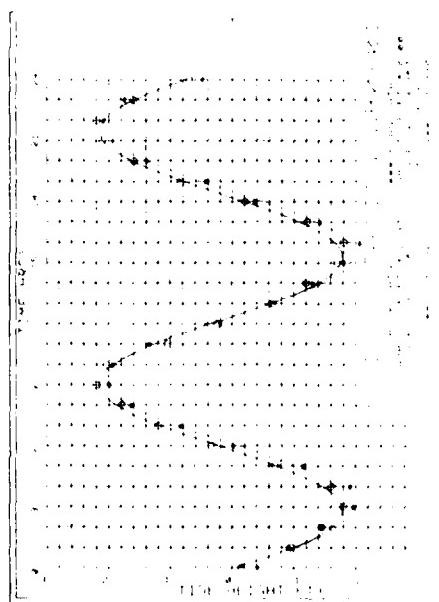
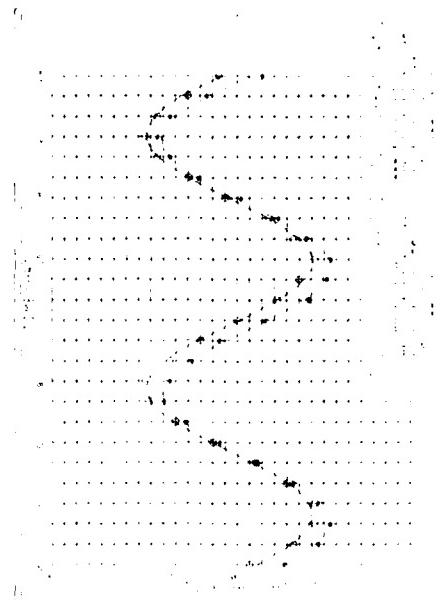
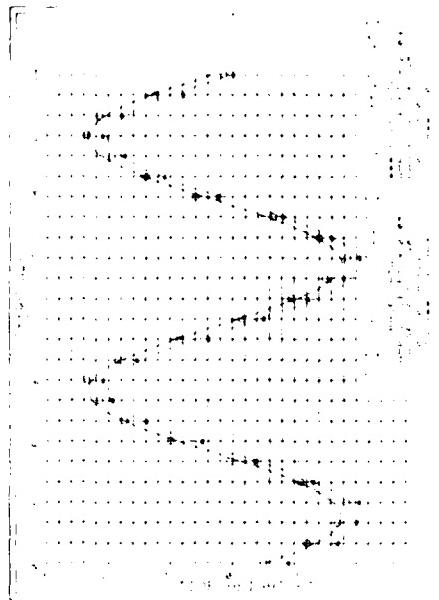


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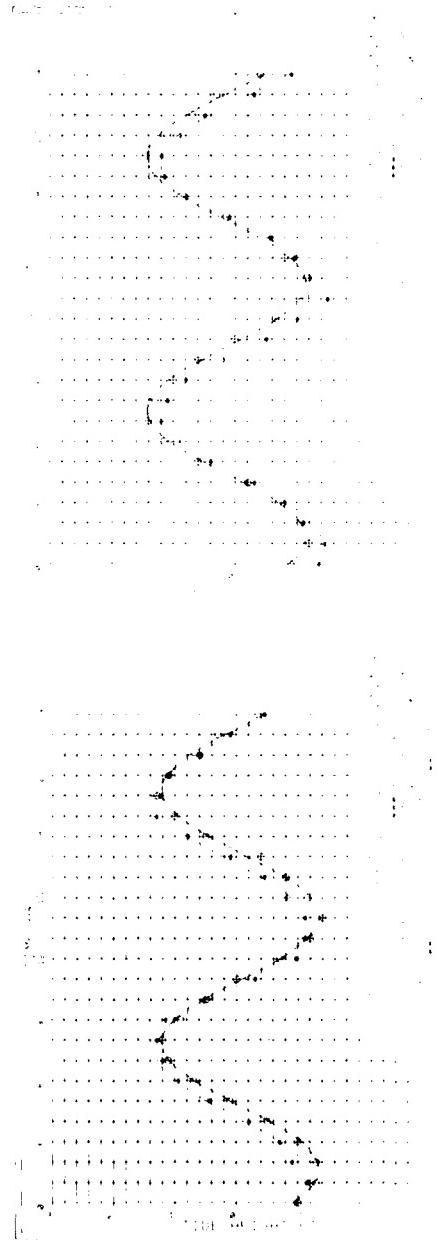
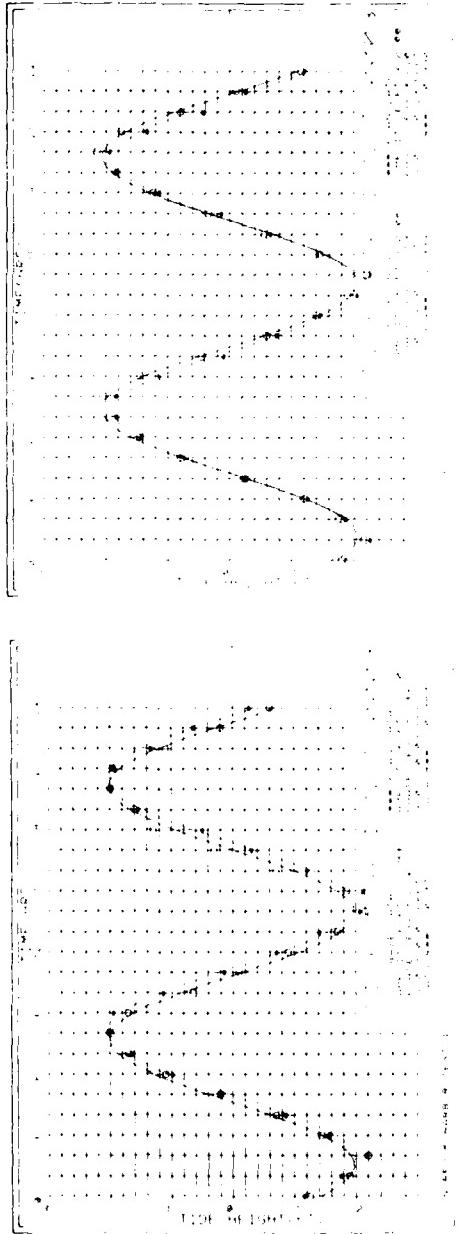
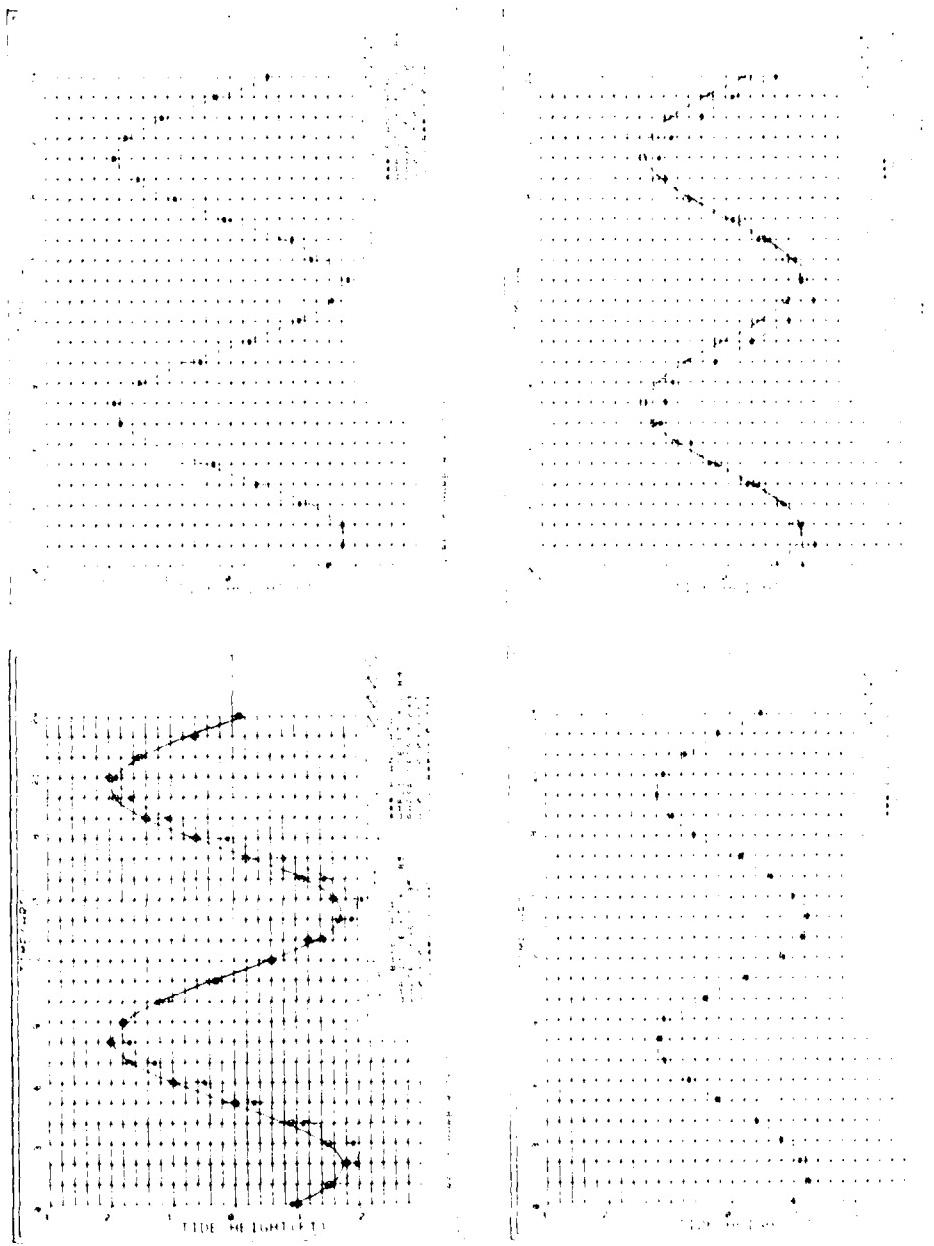


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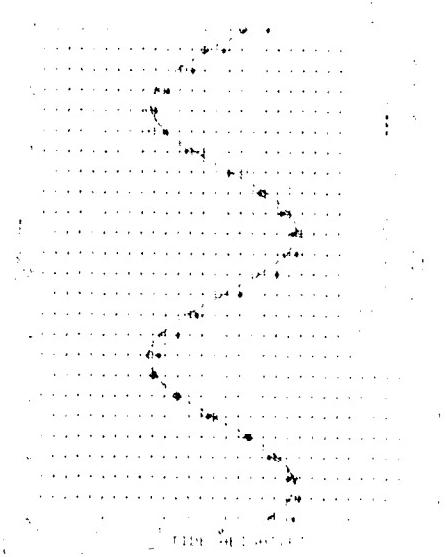
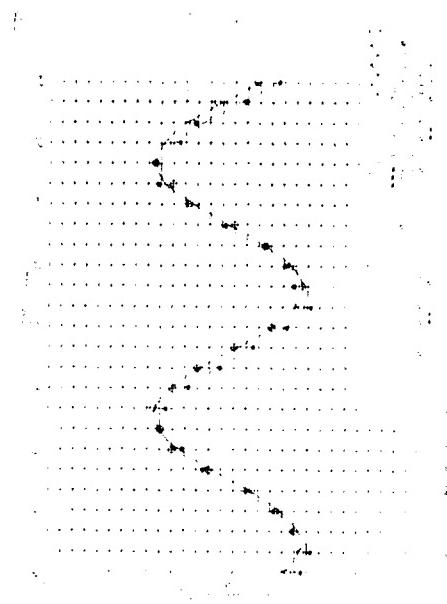
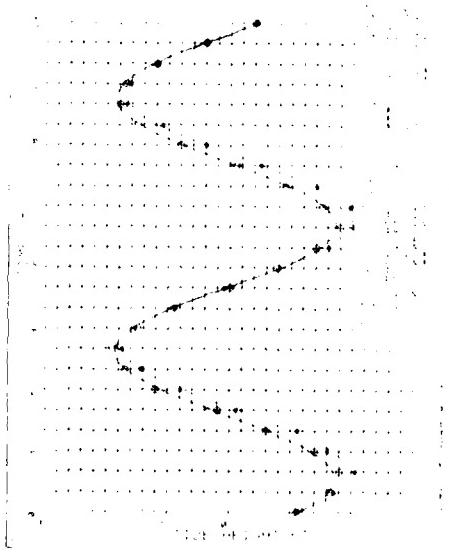
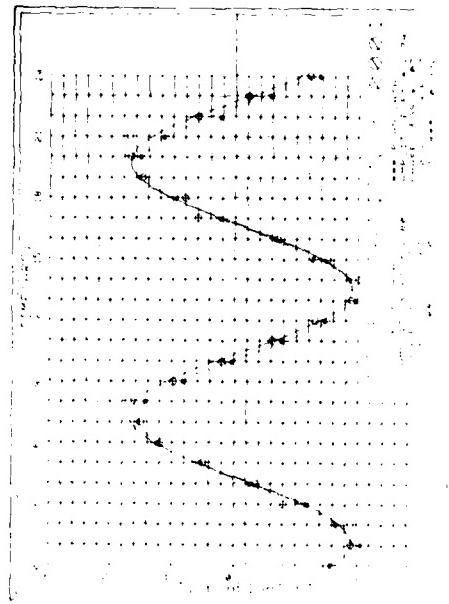


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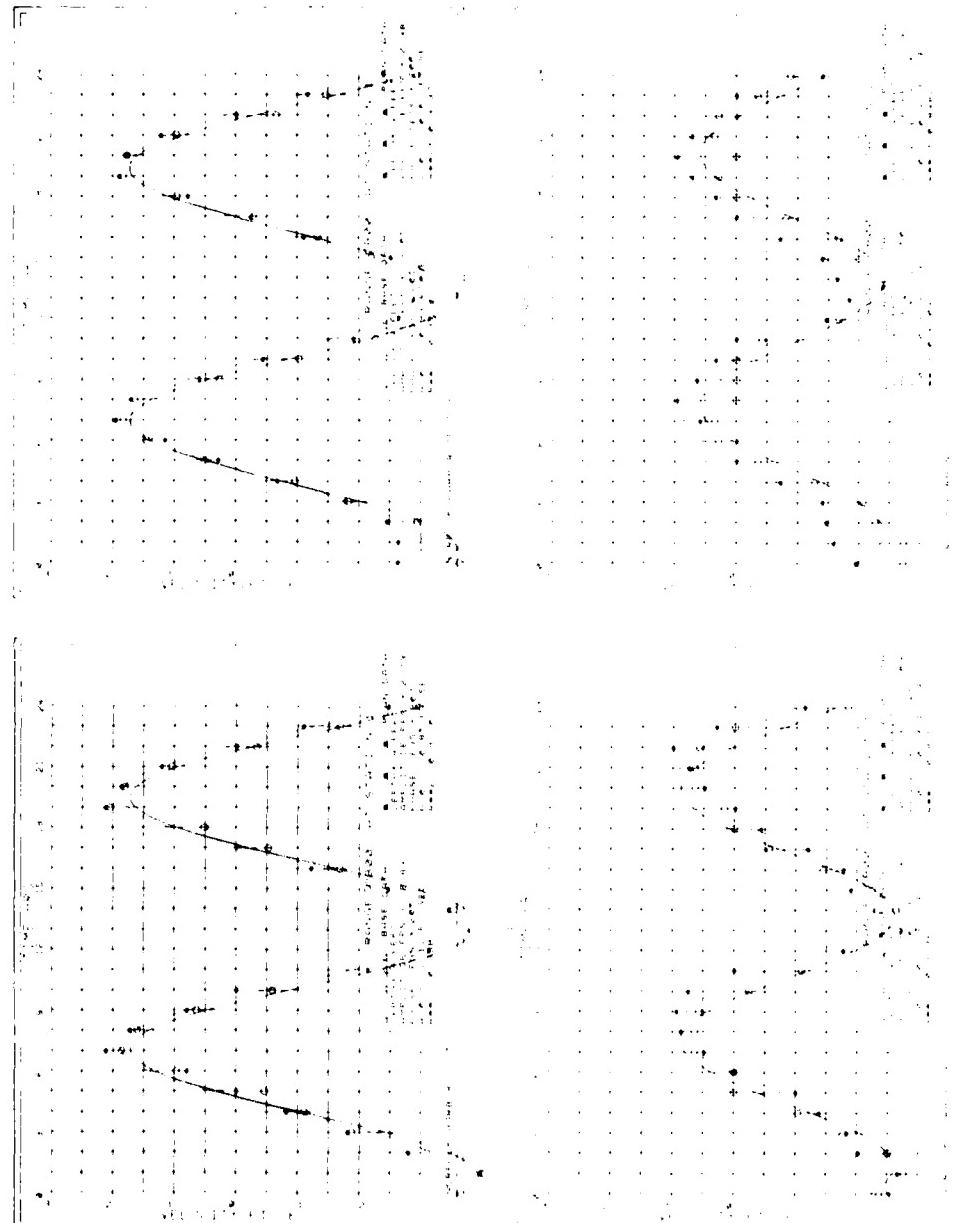


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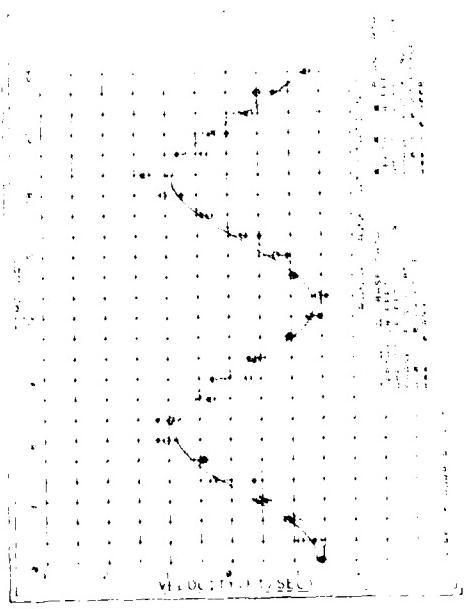
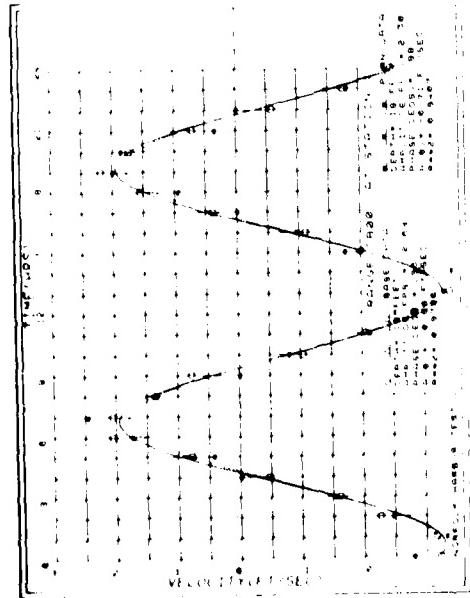
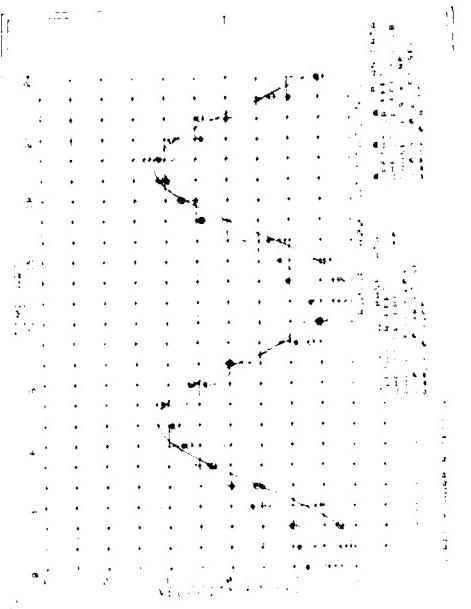
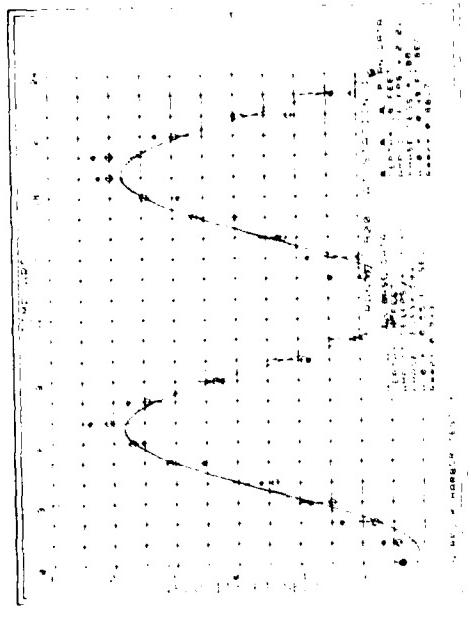


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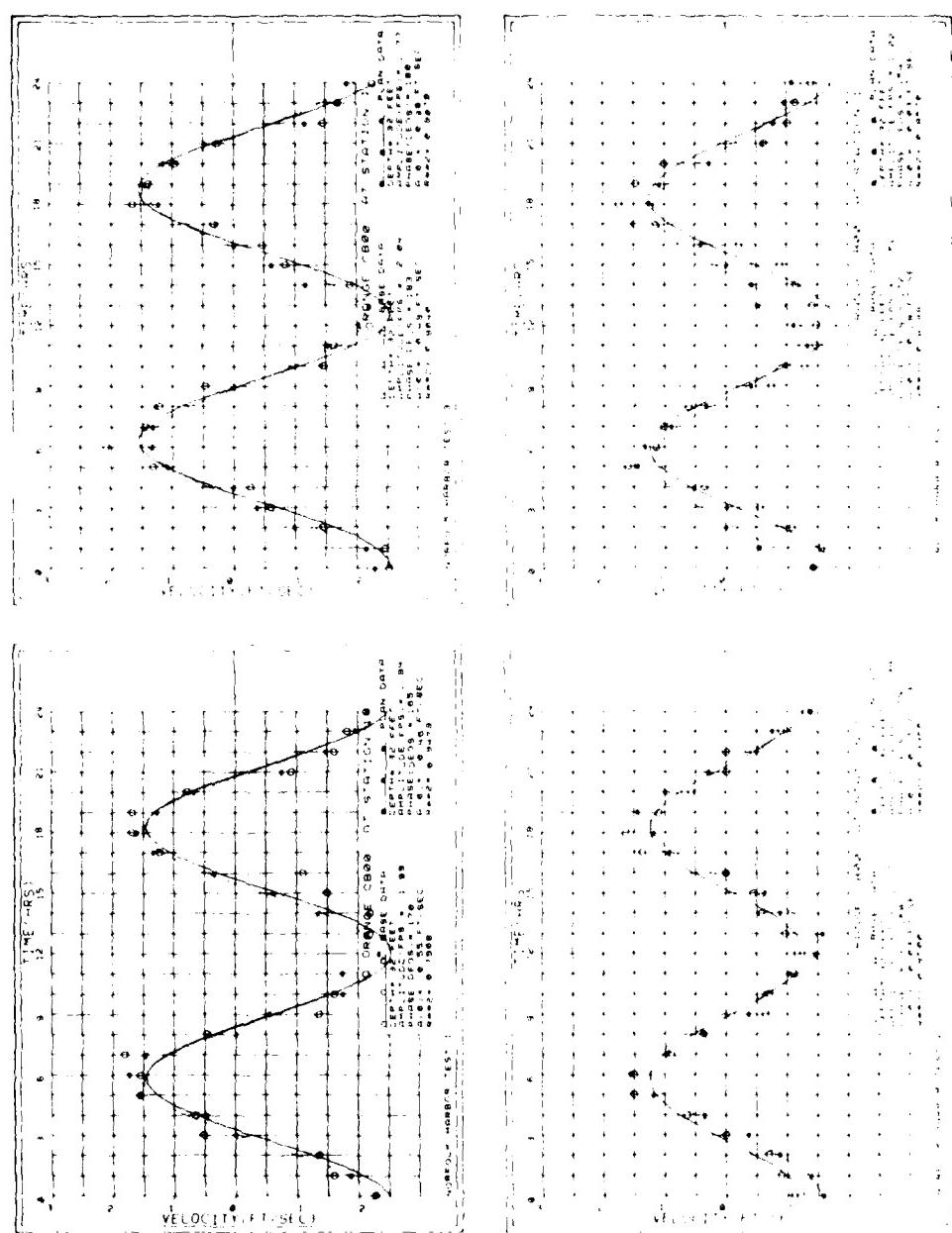


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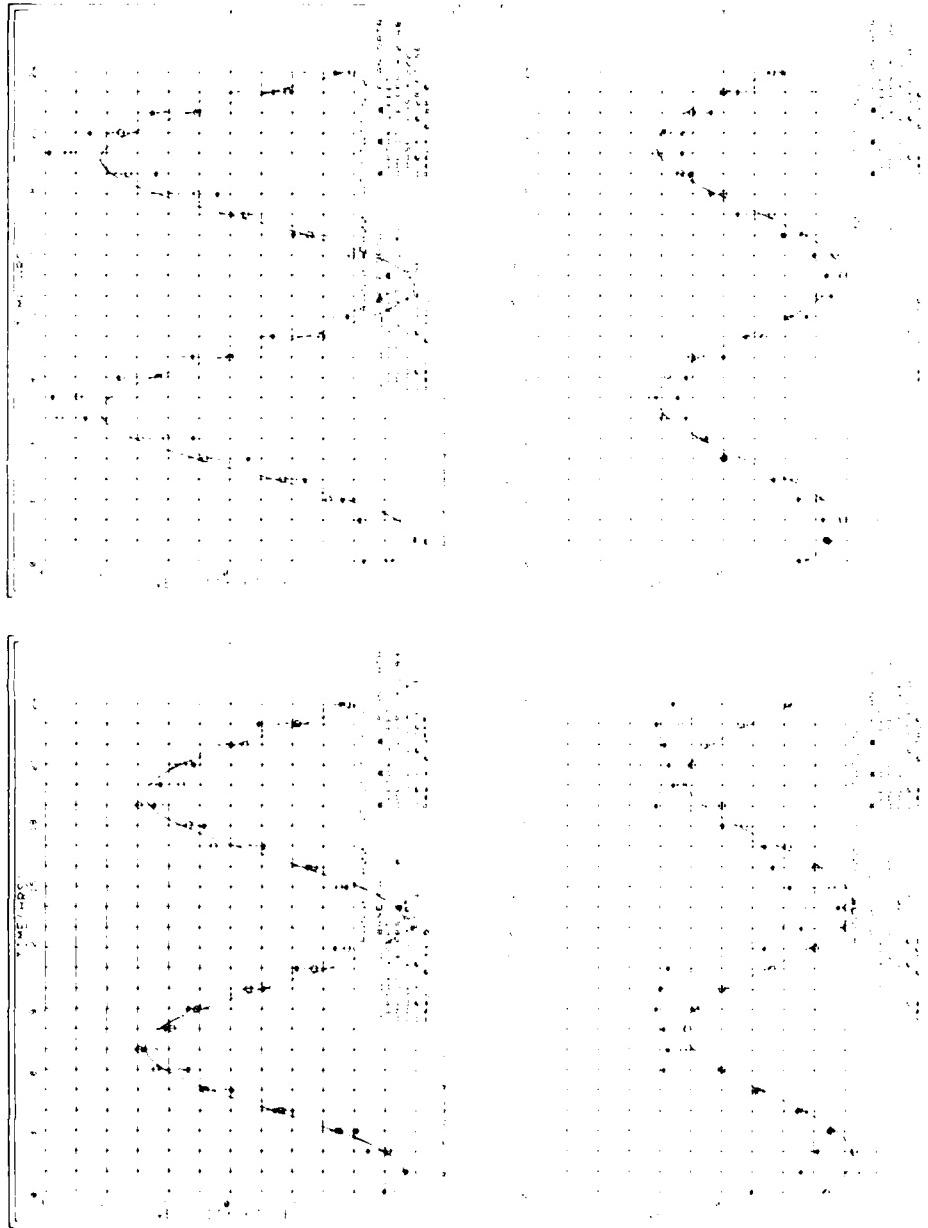


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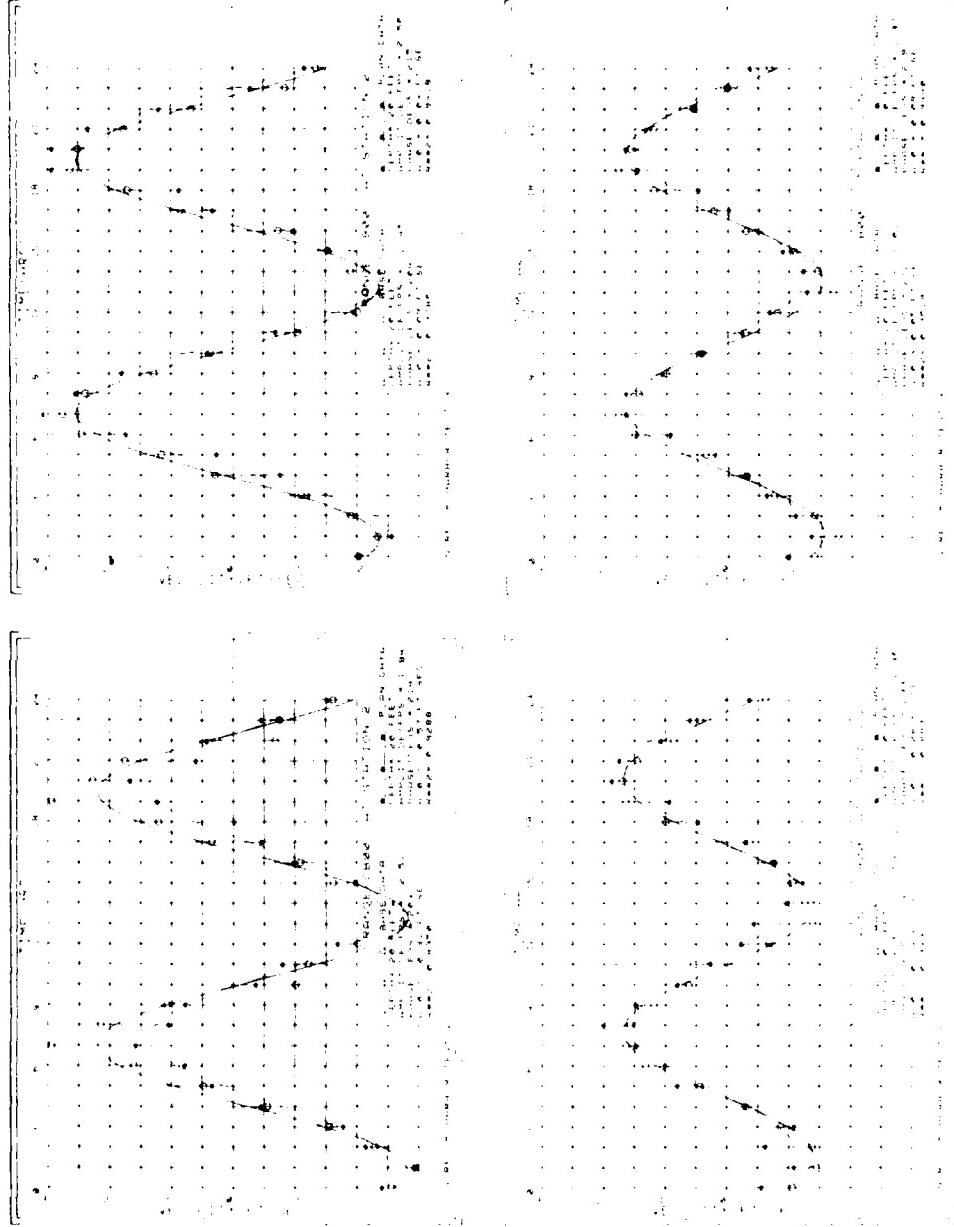


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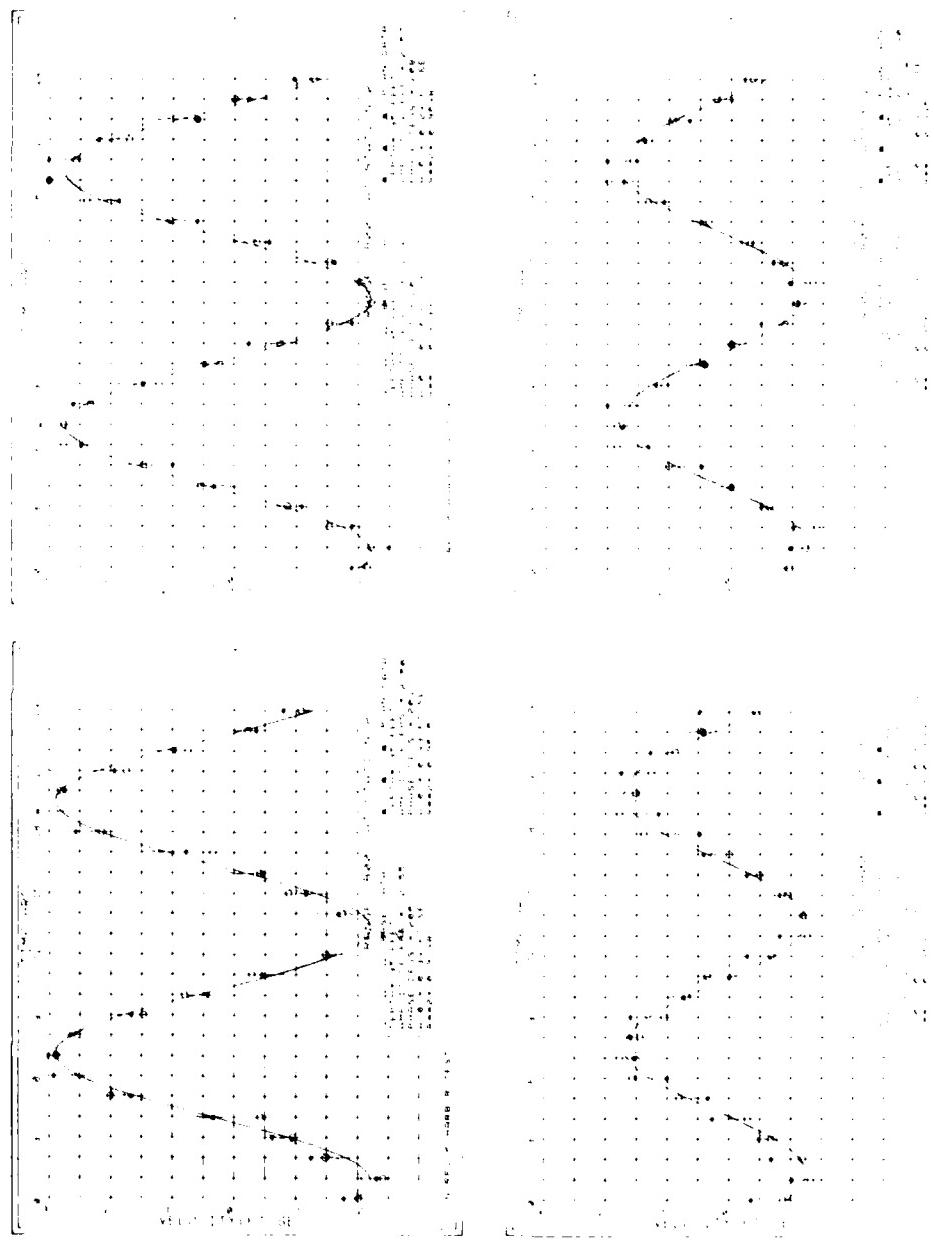


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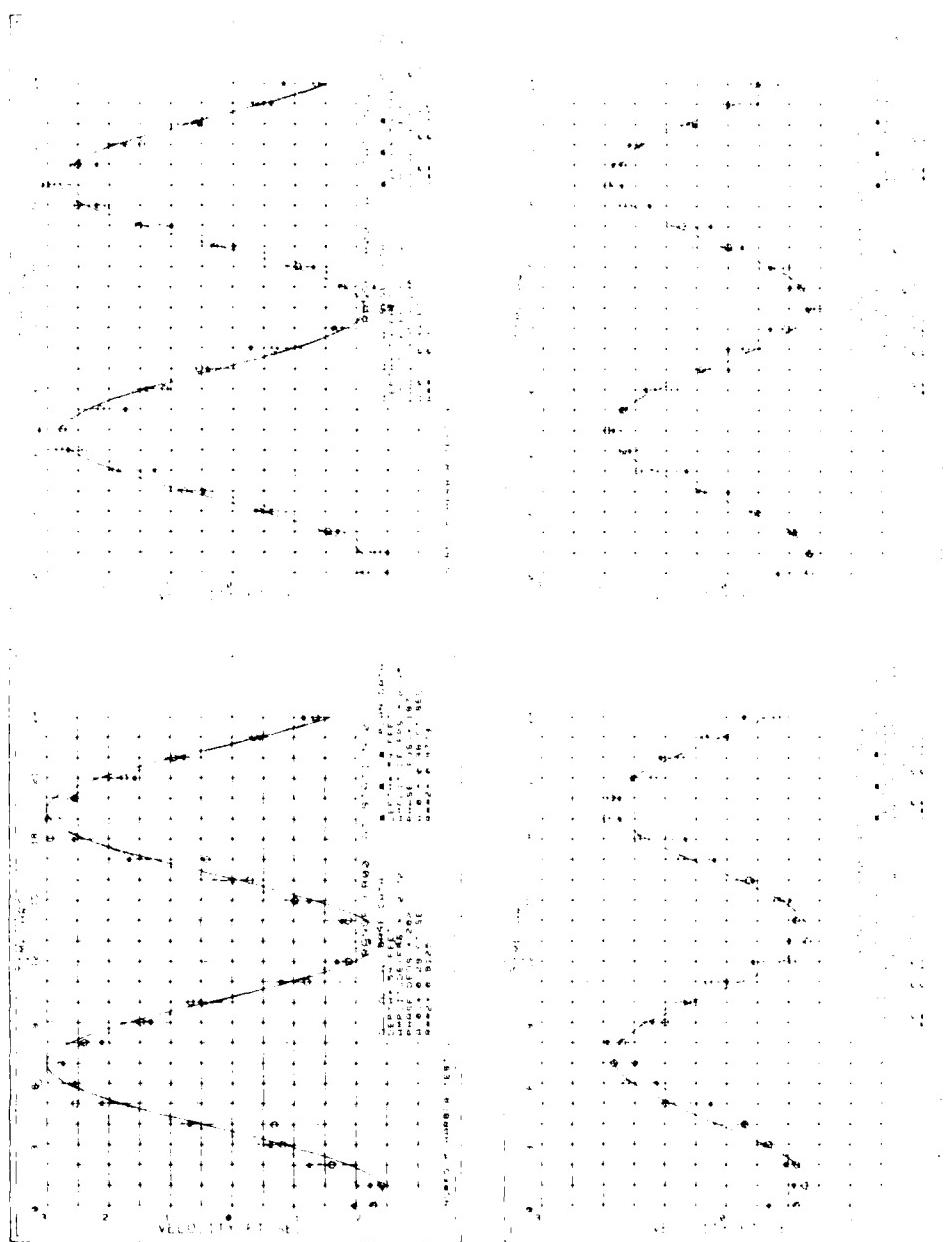


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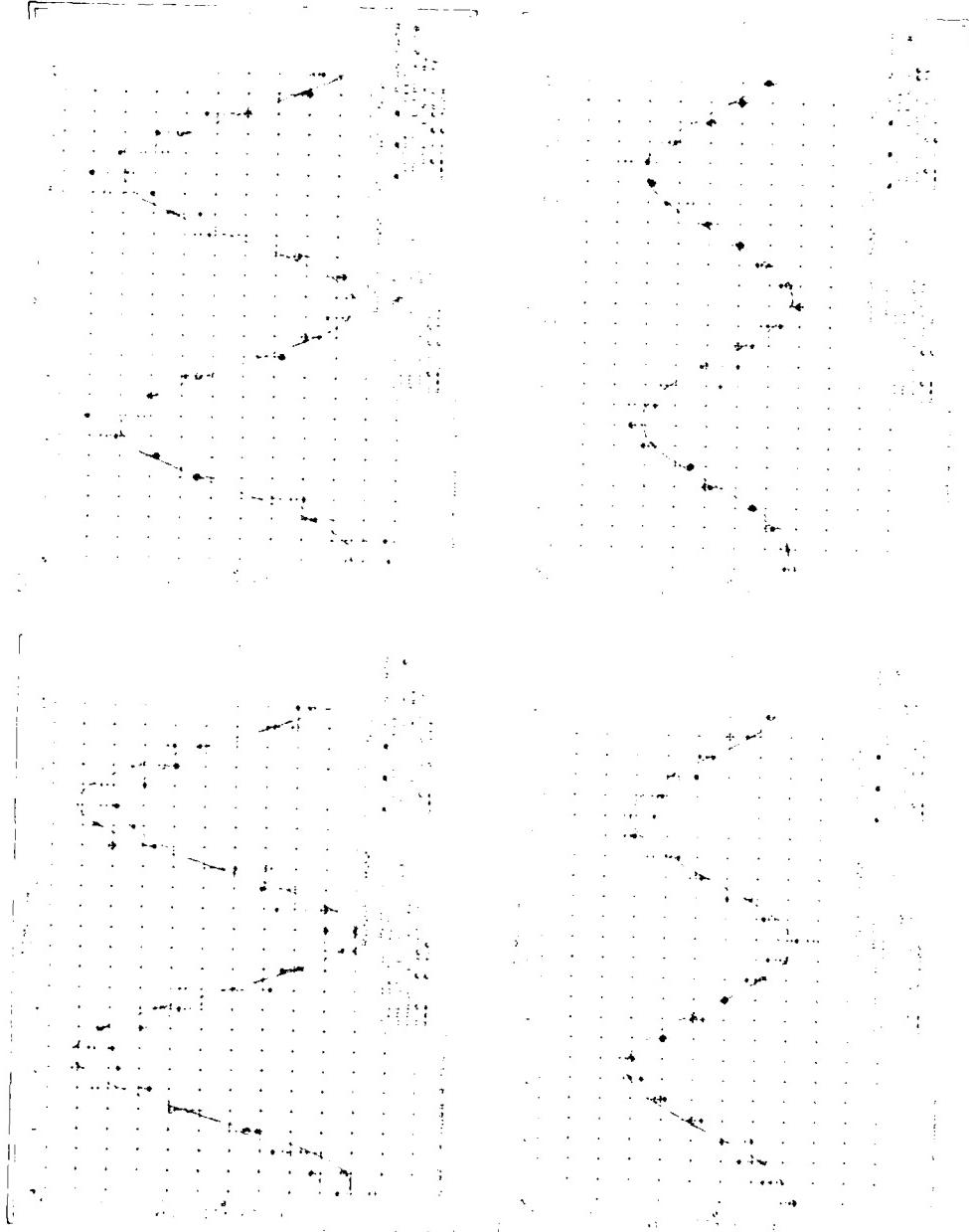


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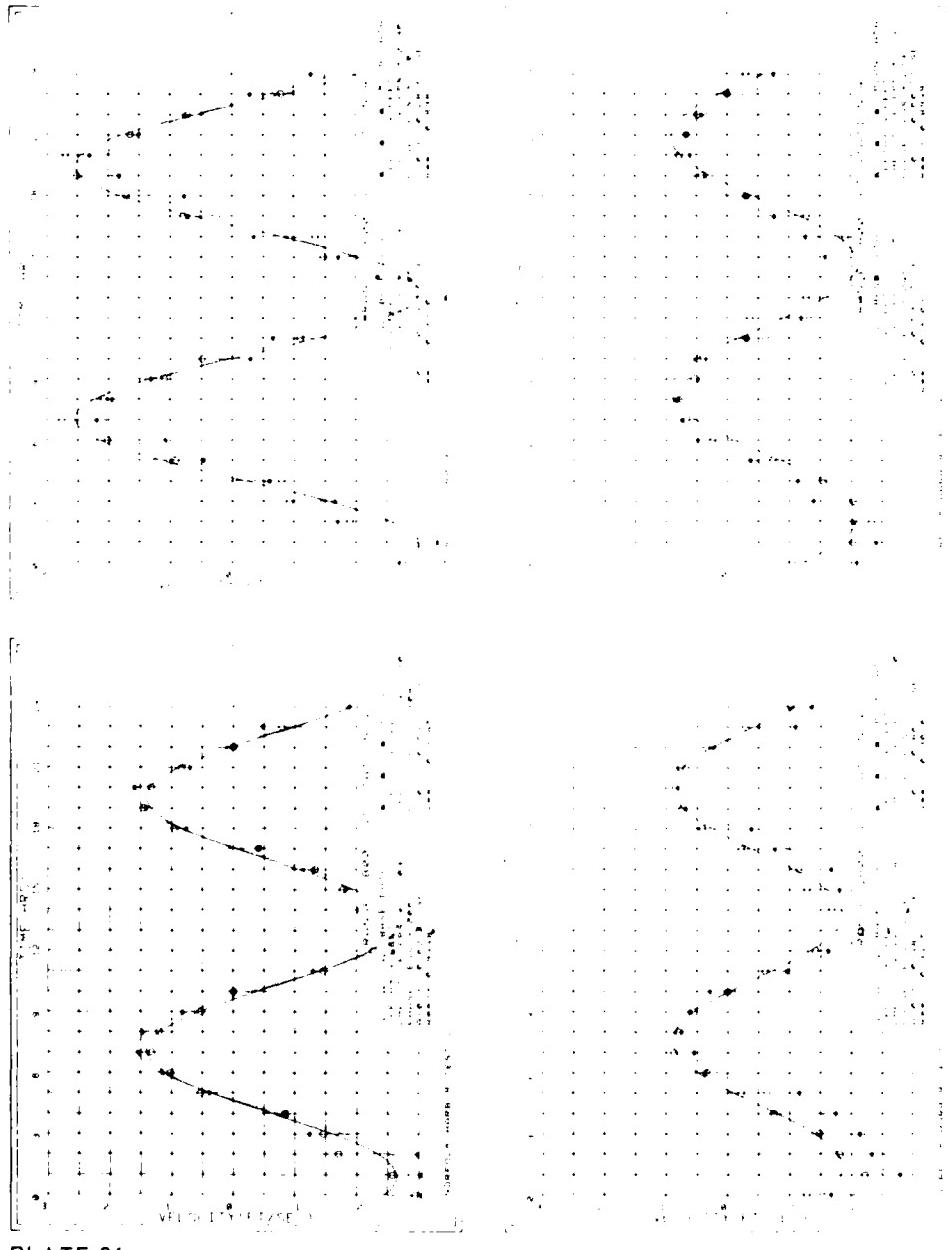


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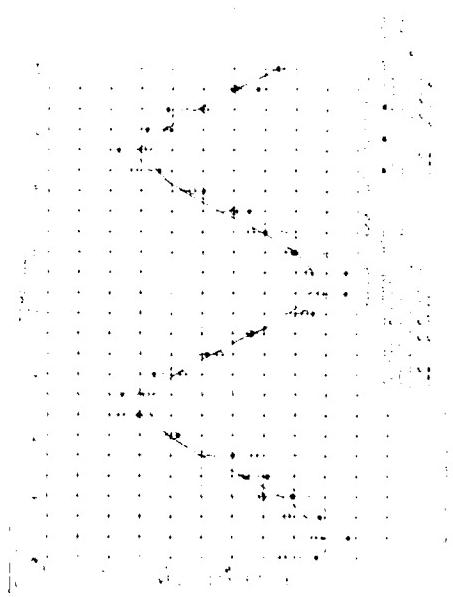
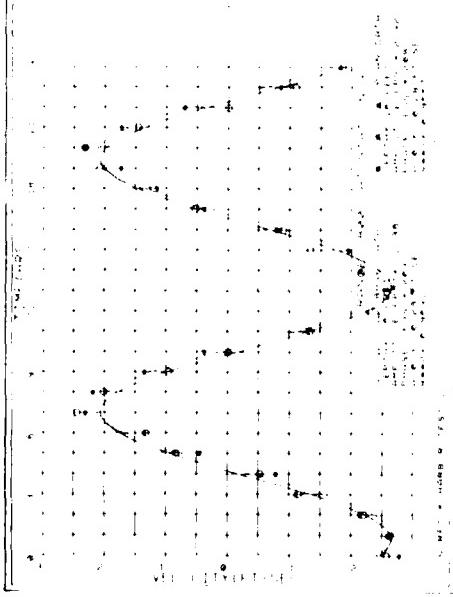
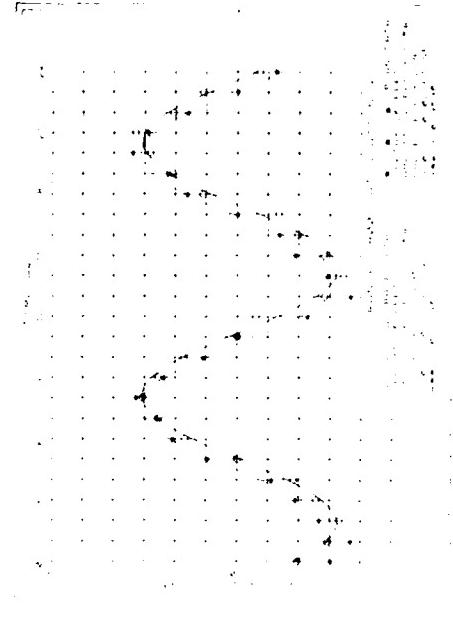
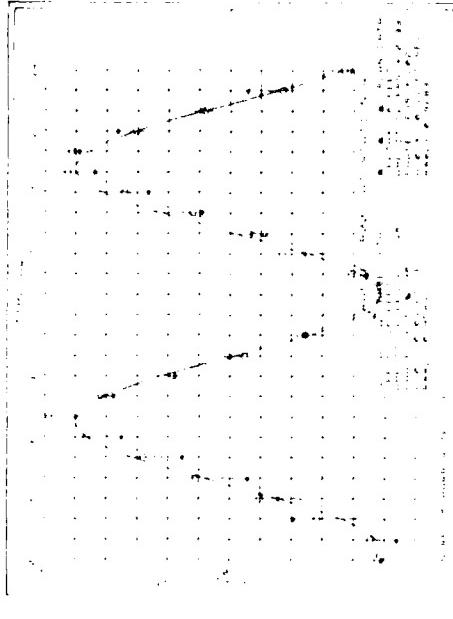


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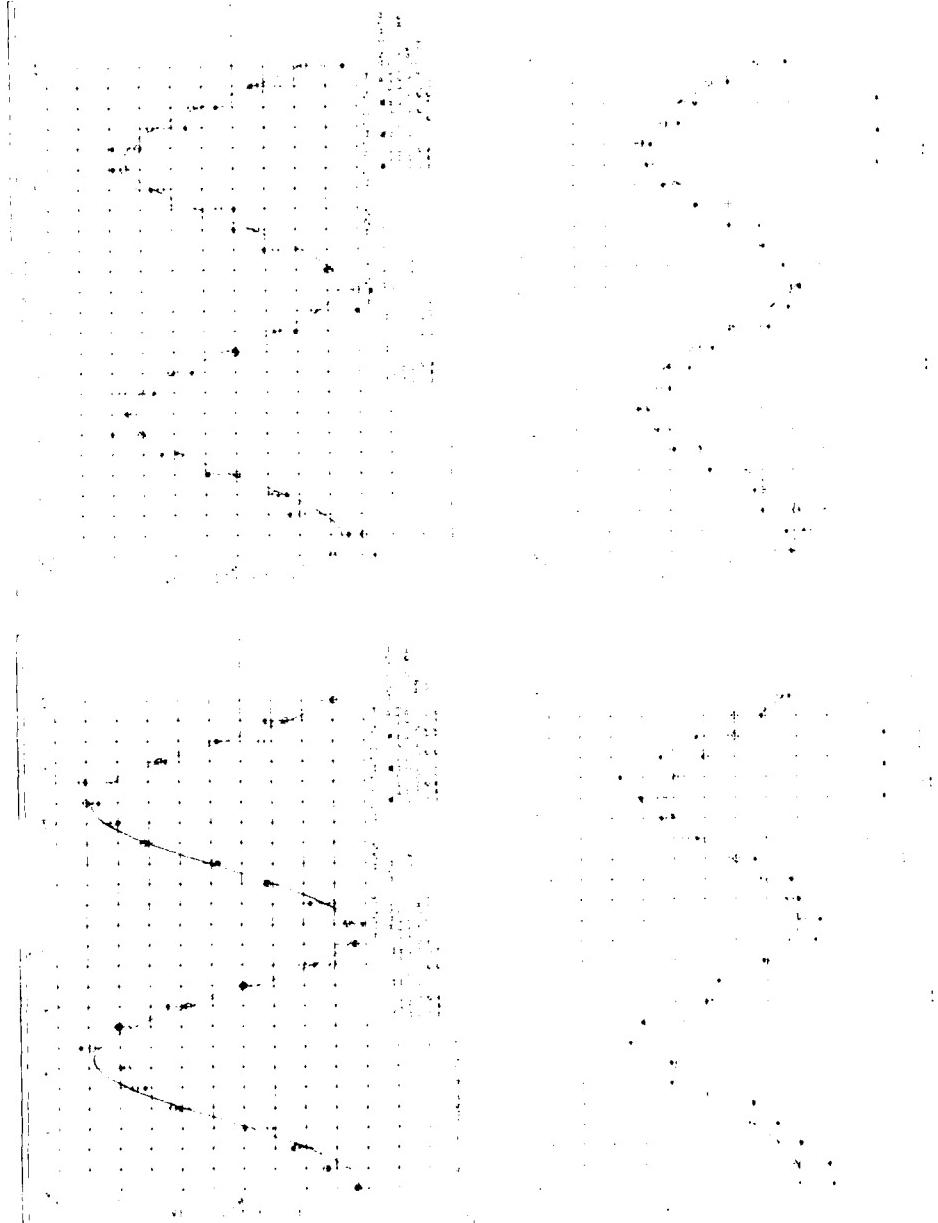


PLATE 28

PLATE 29

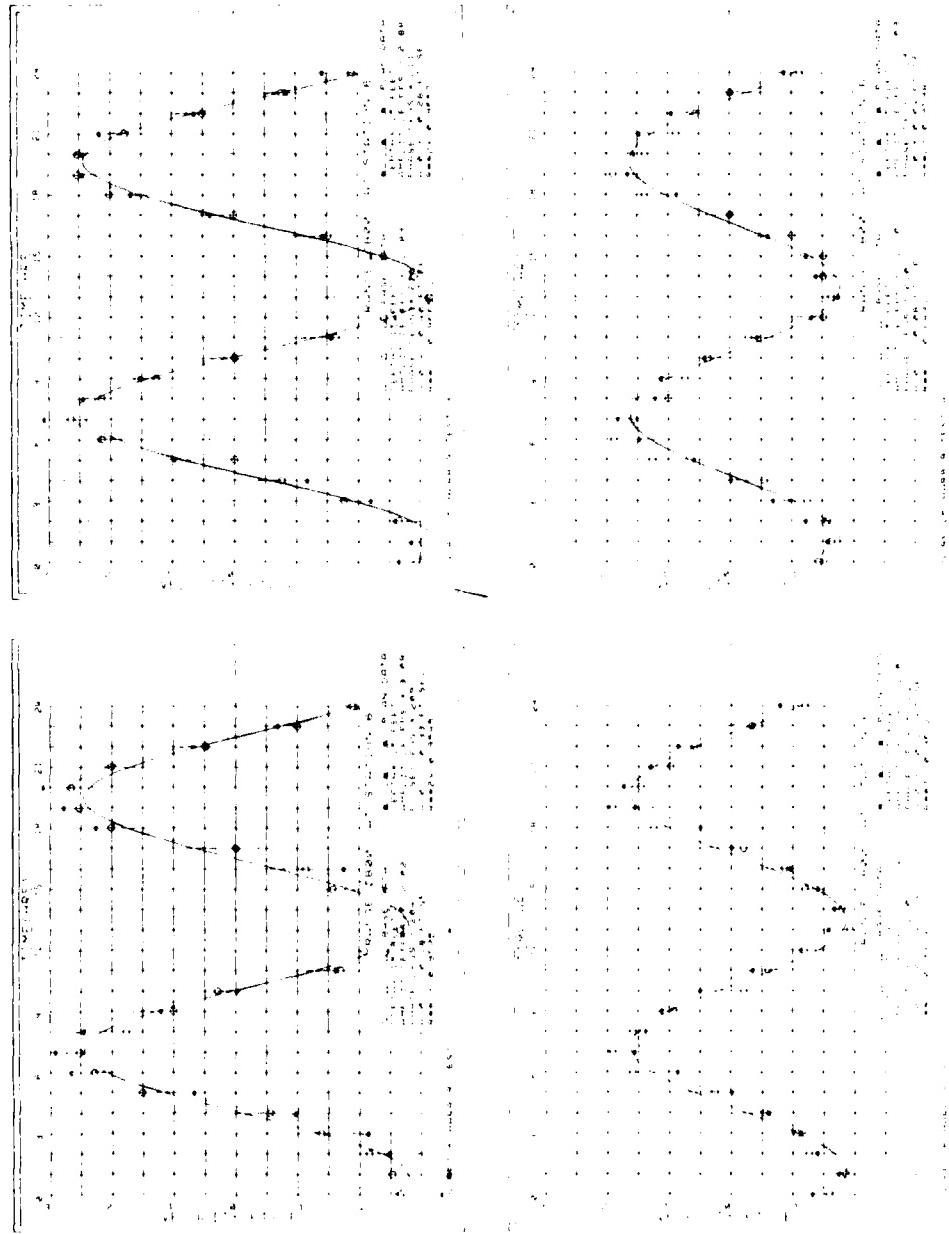


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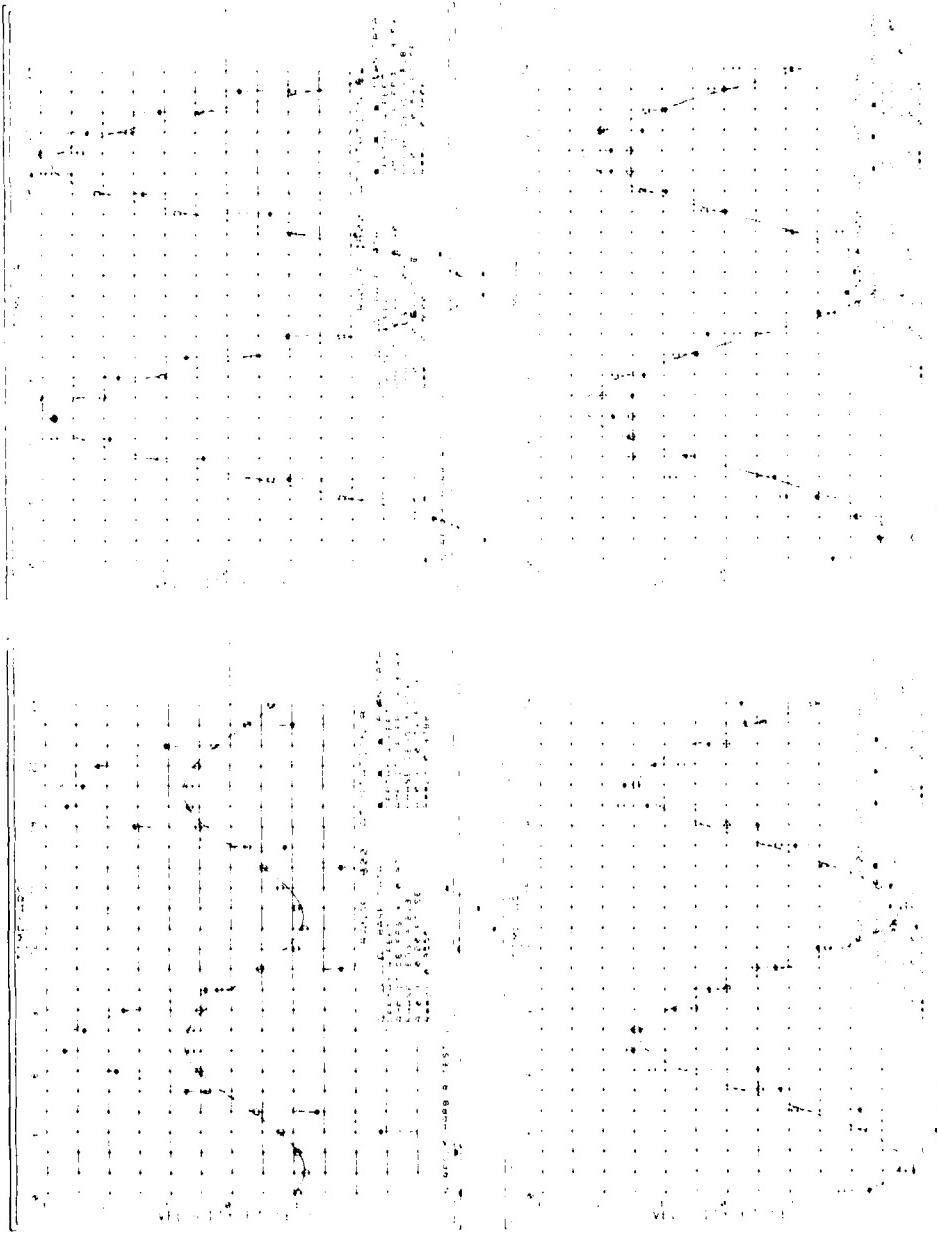


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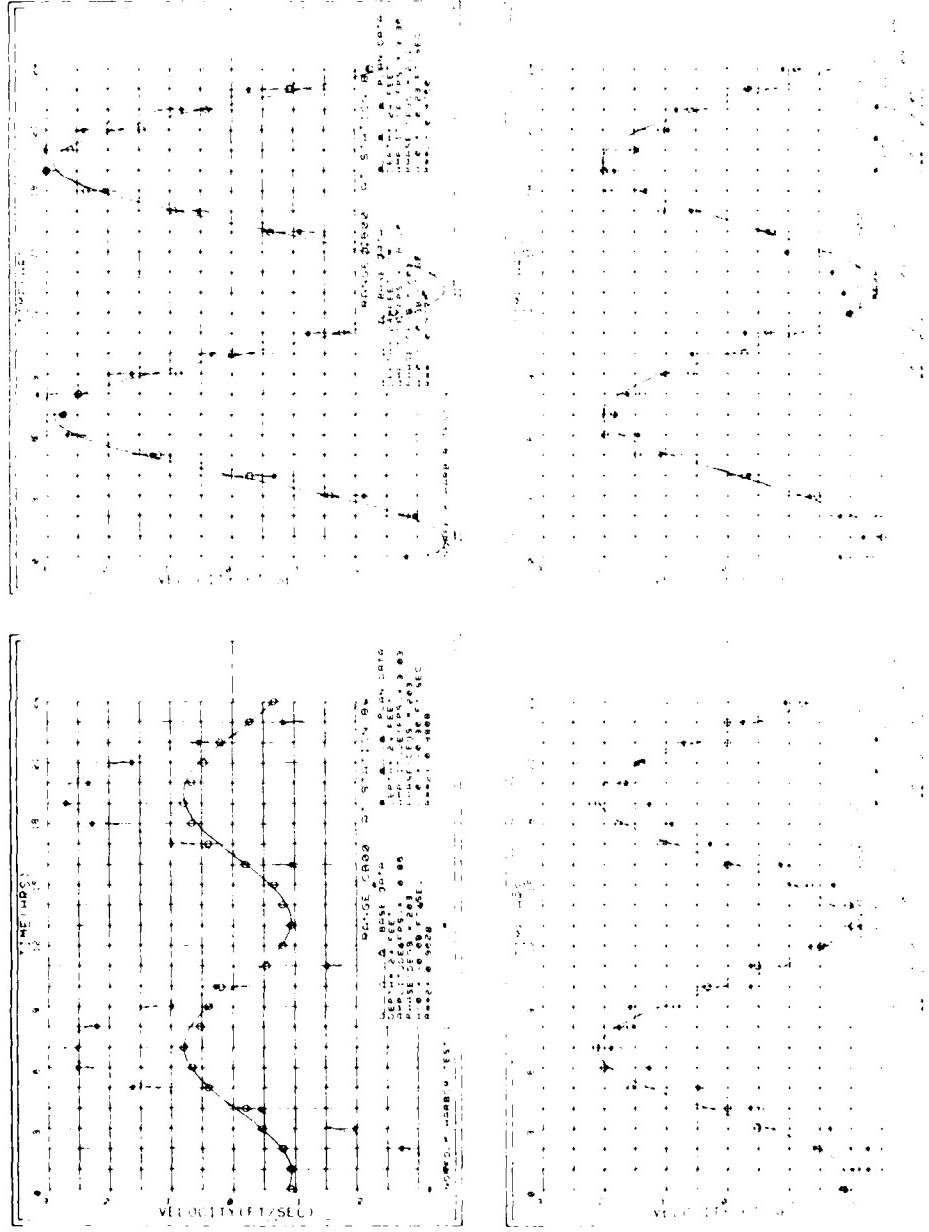


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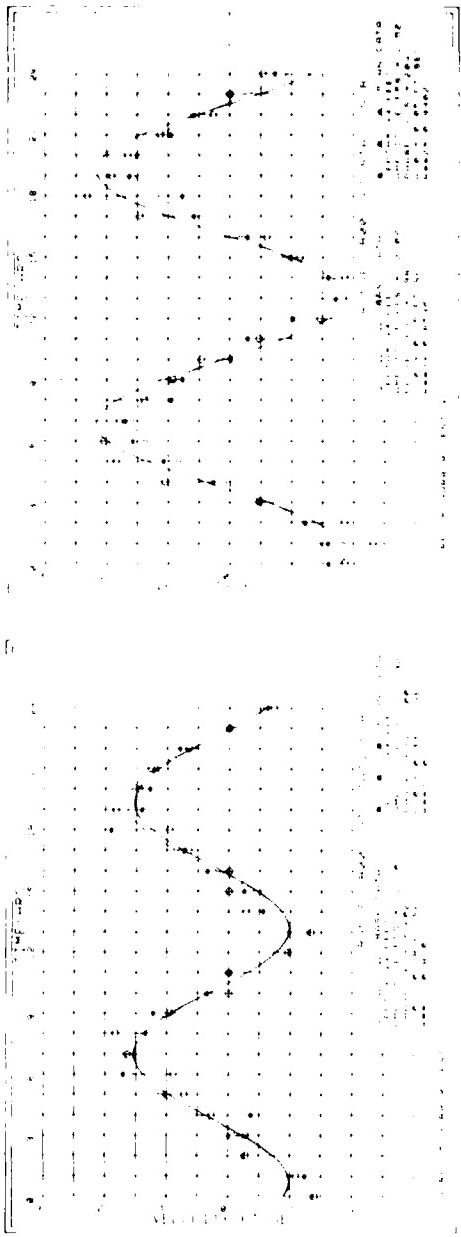
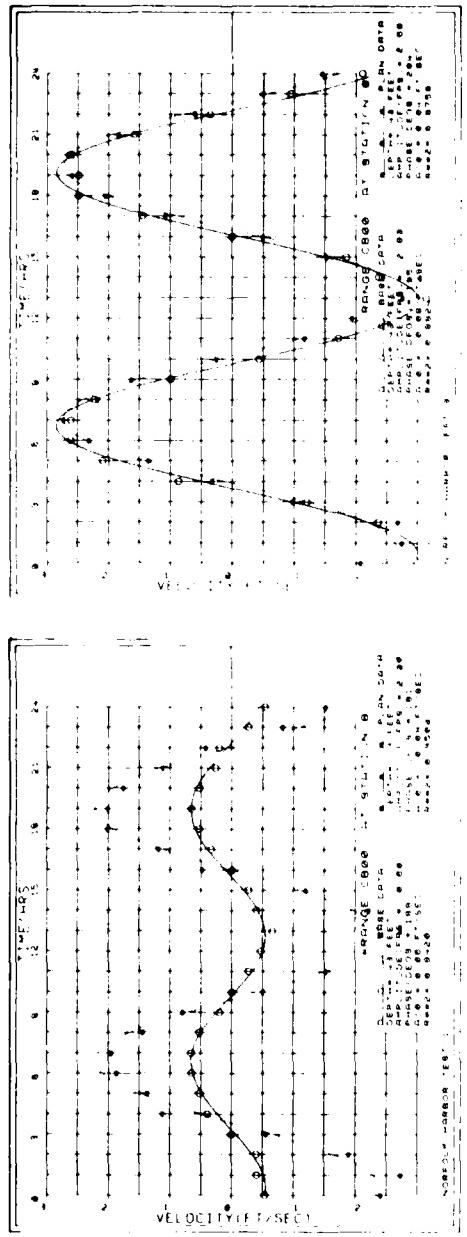


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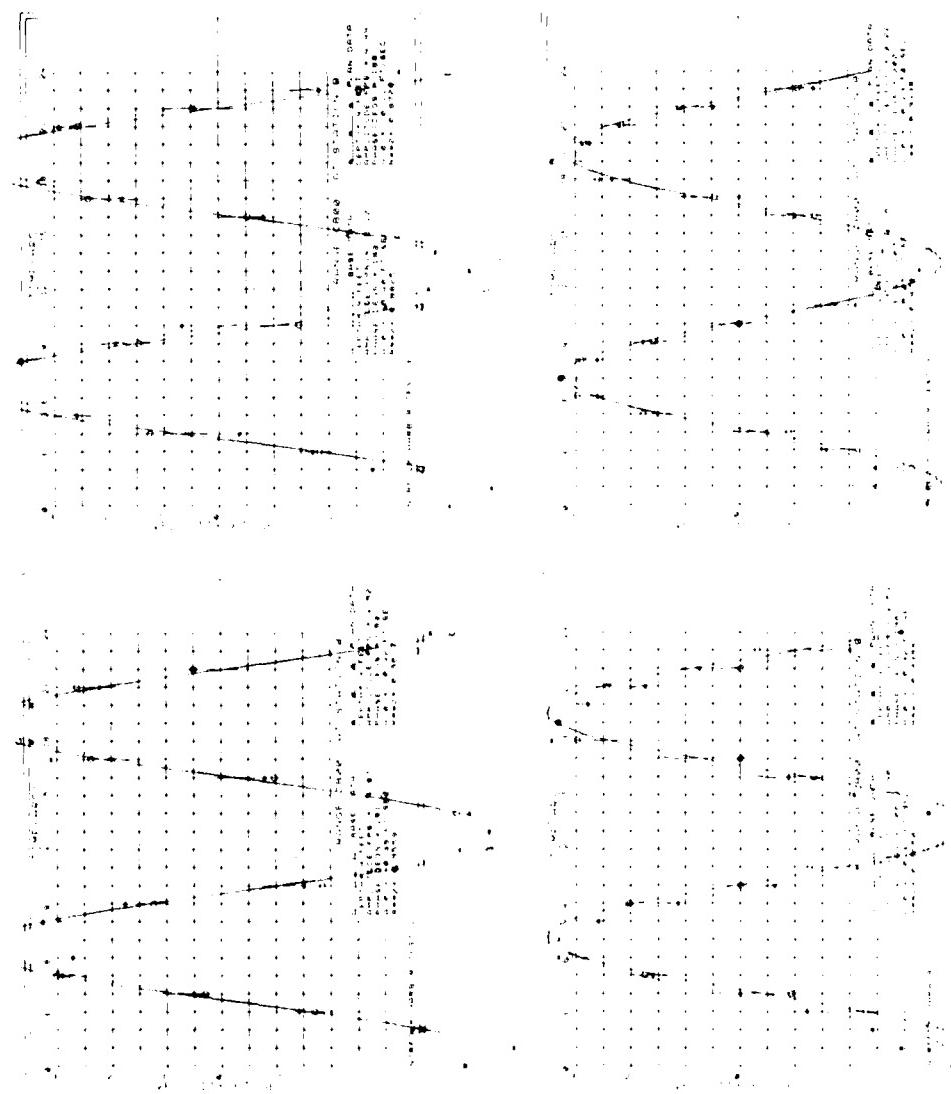


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PLATE 35

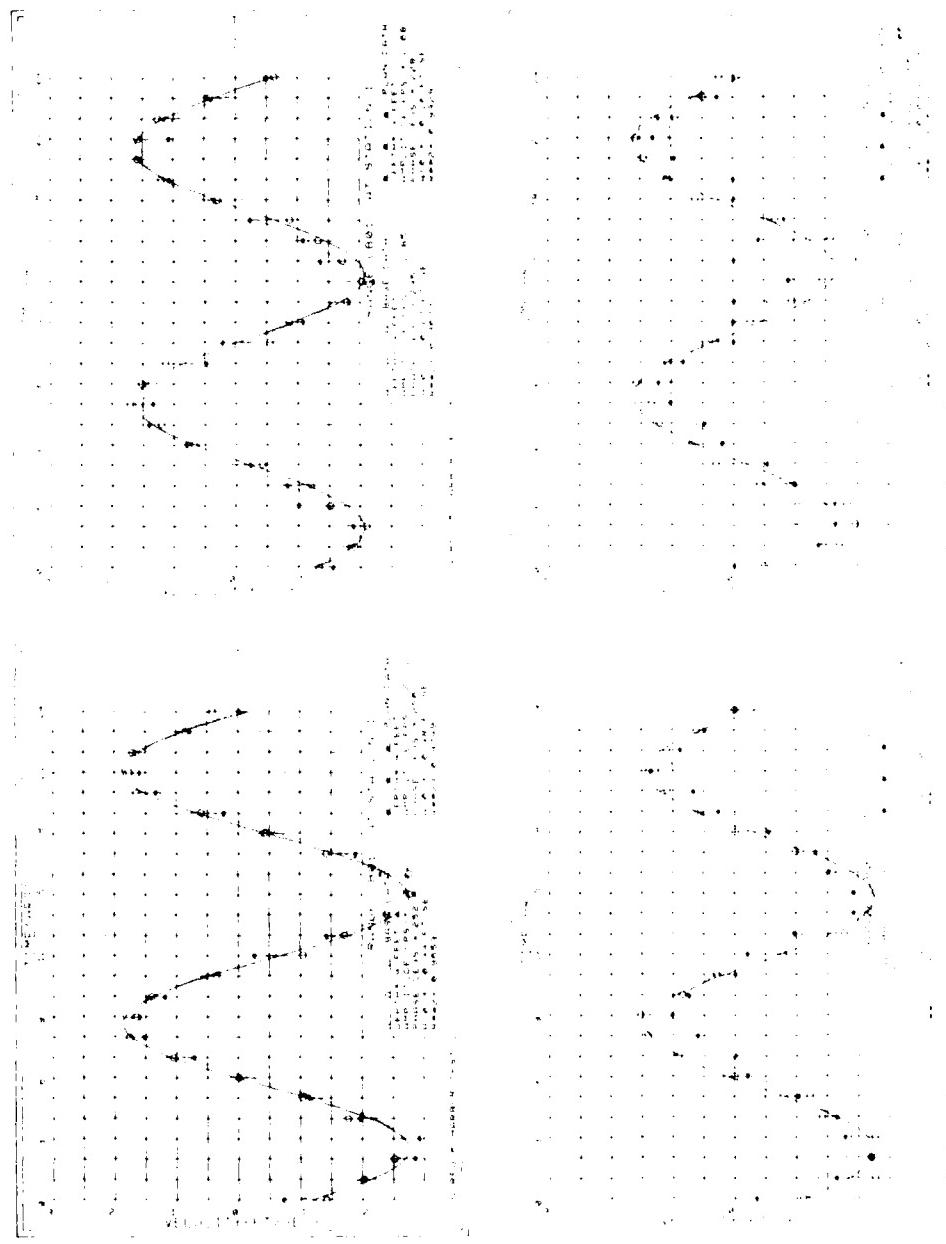


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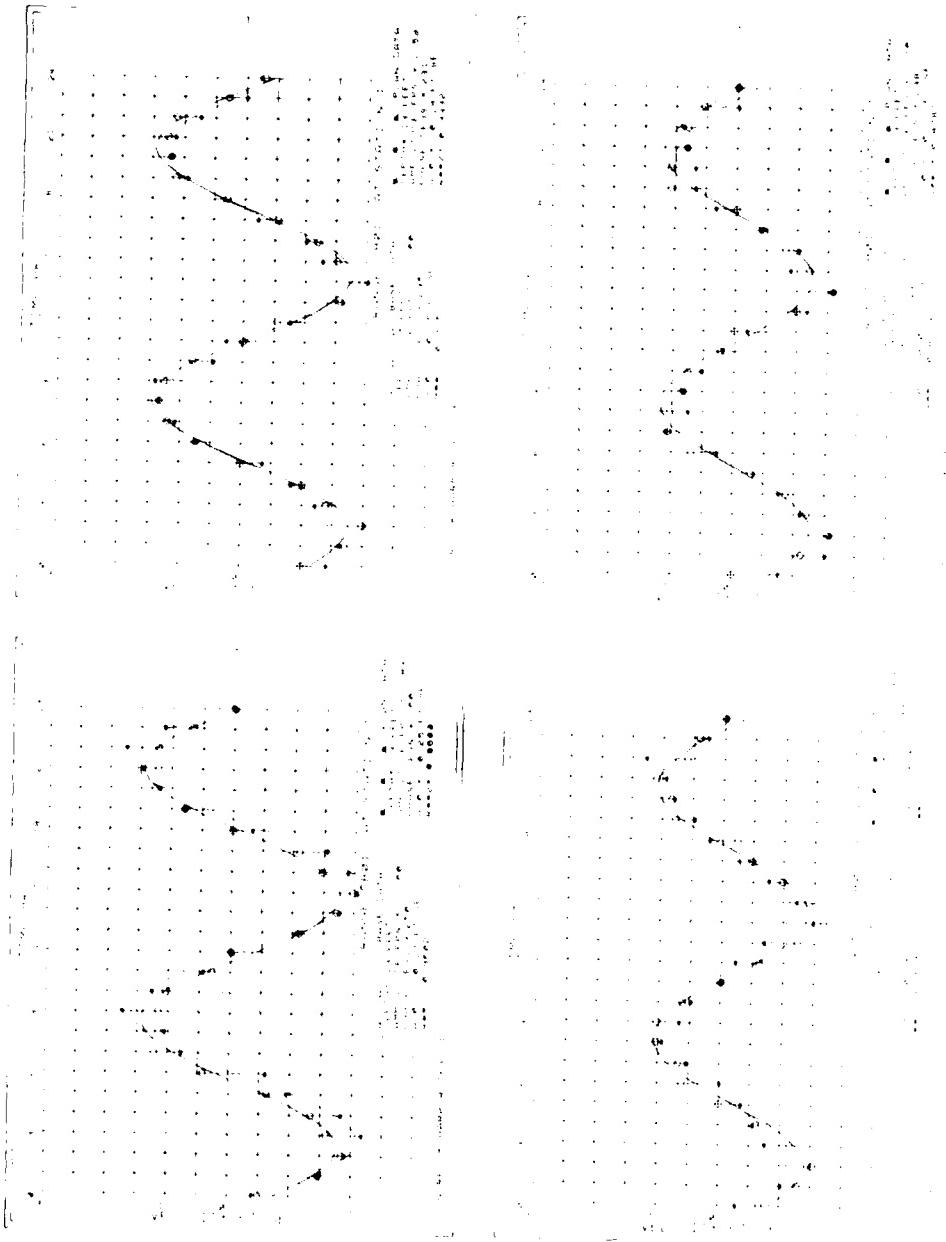


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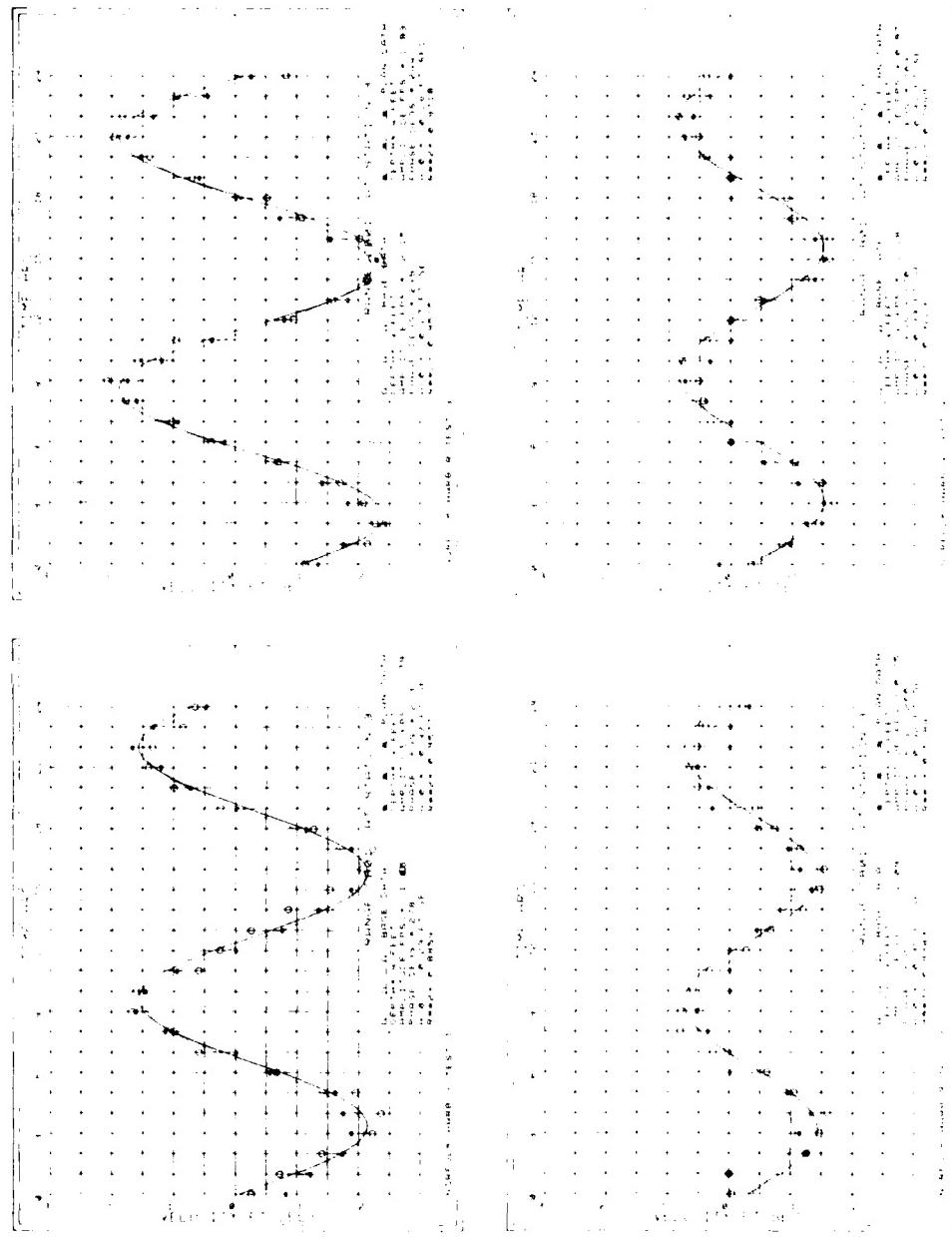


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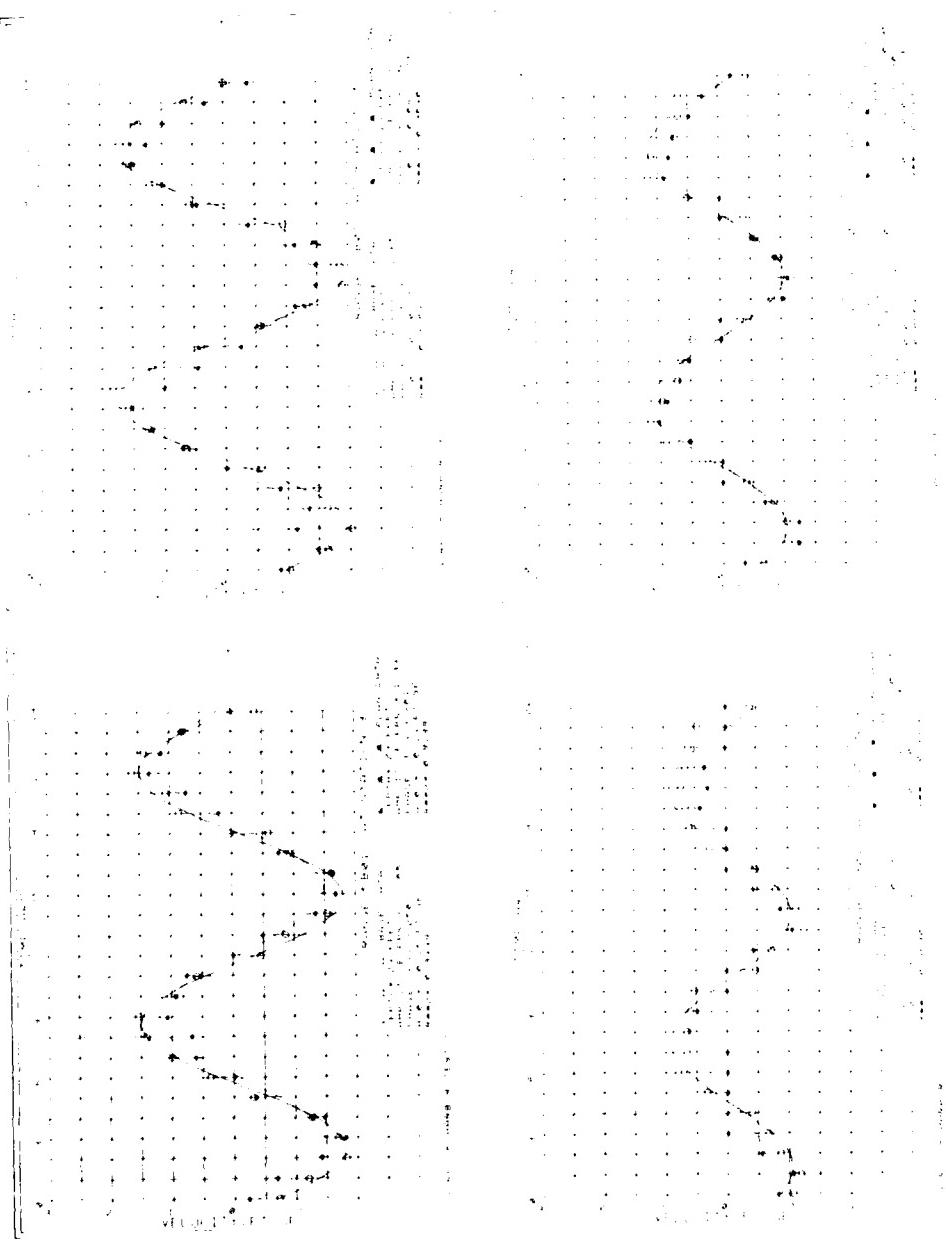


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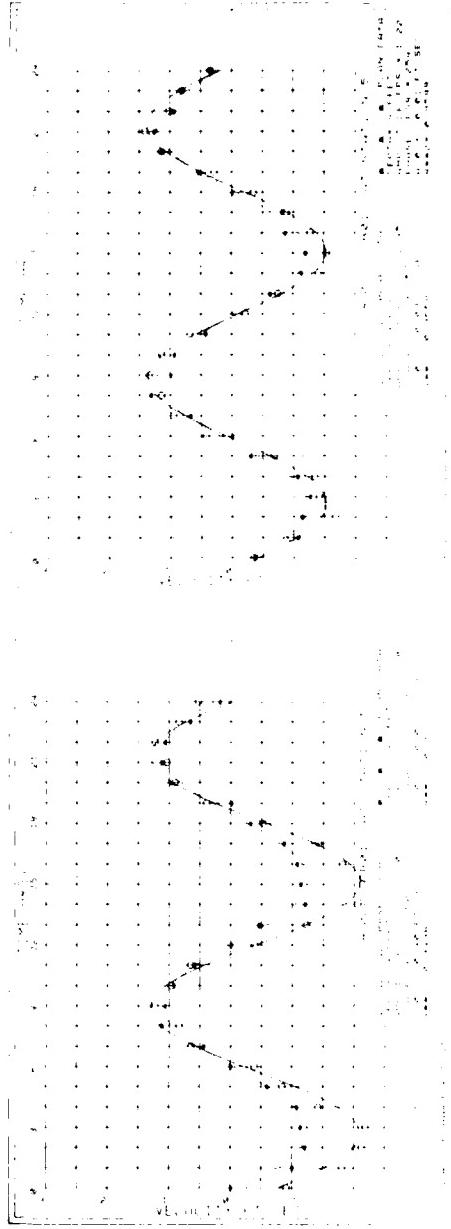
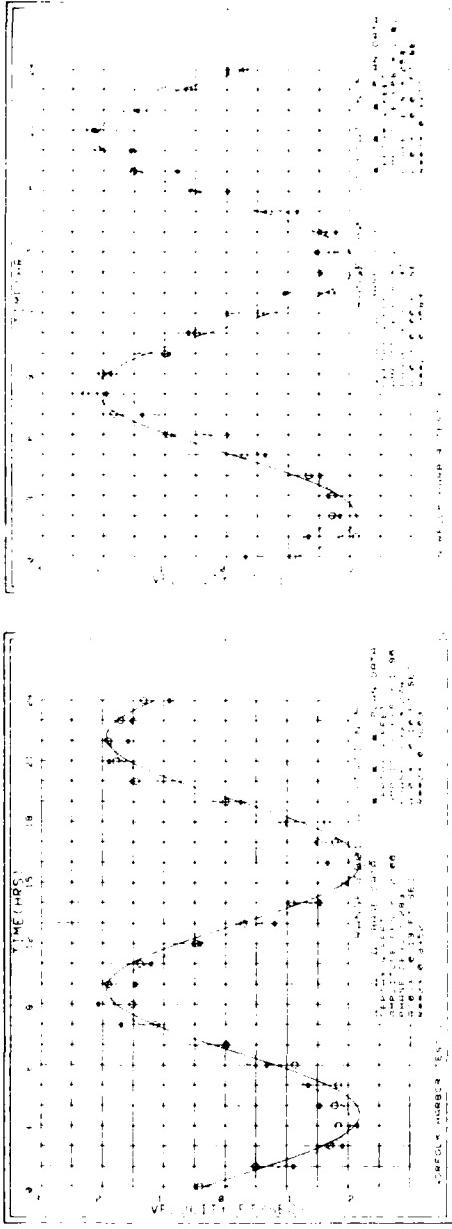


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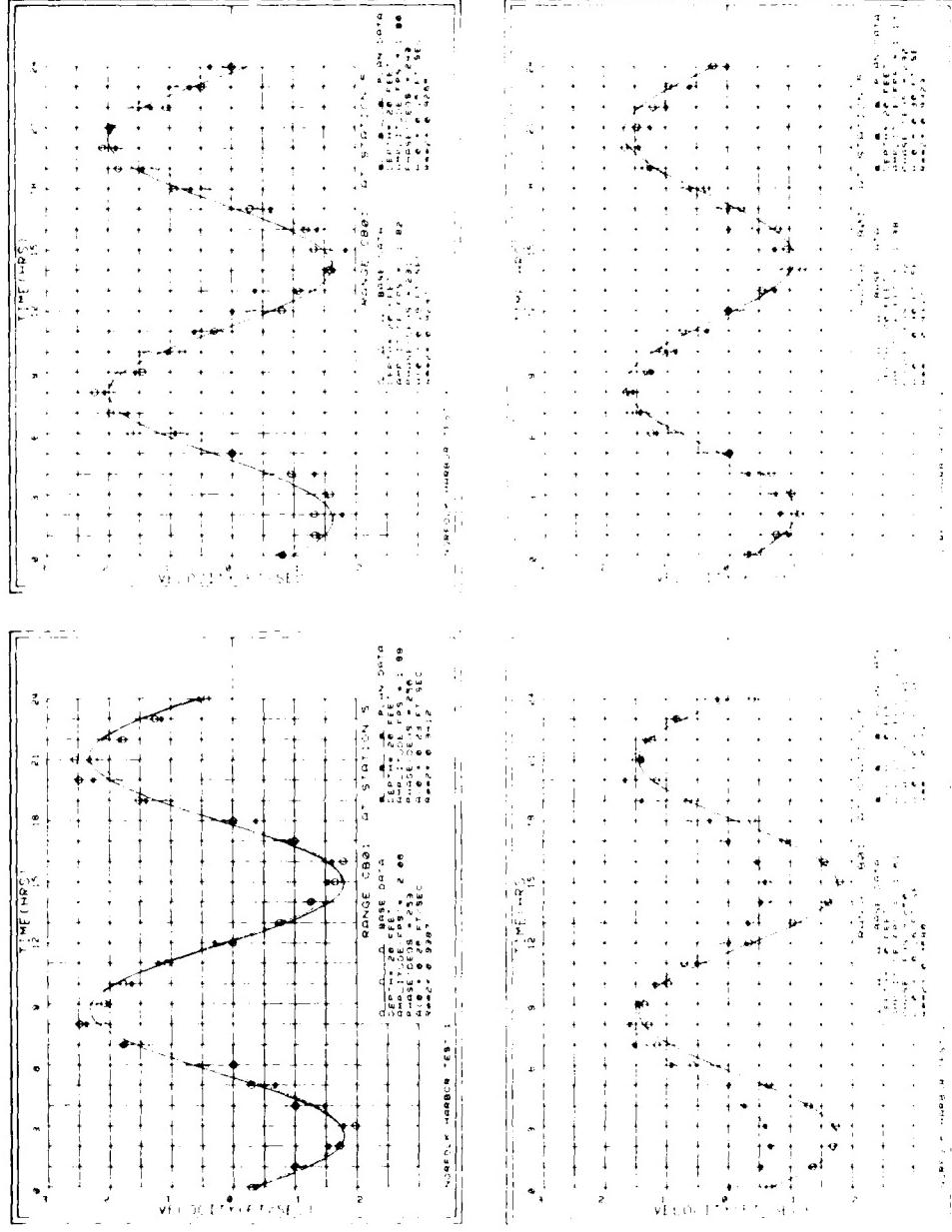


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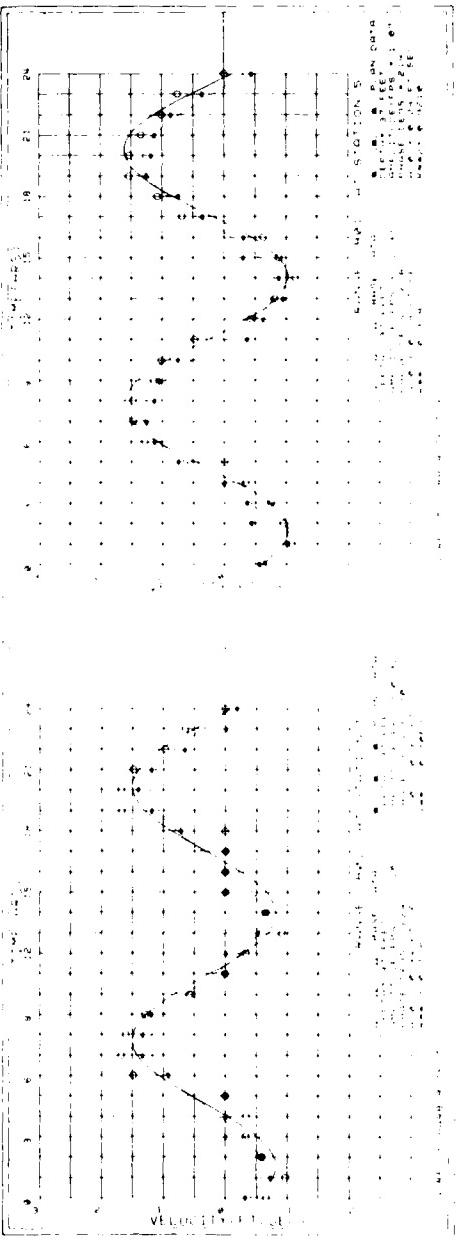
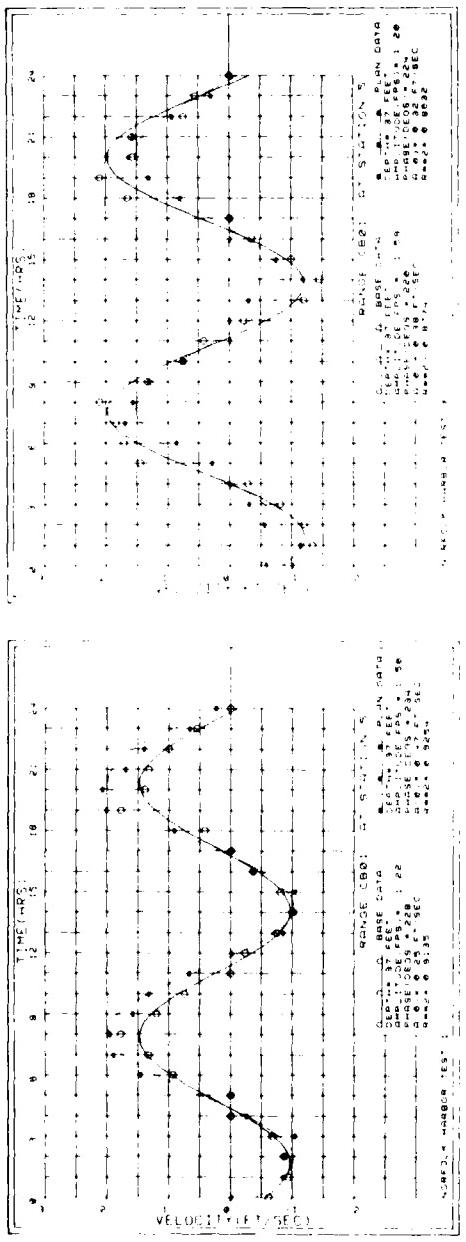


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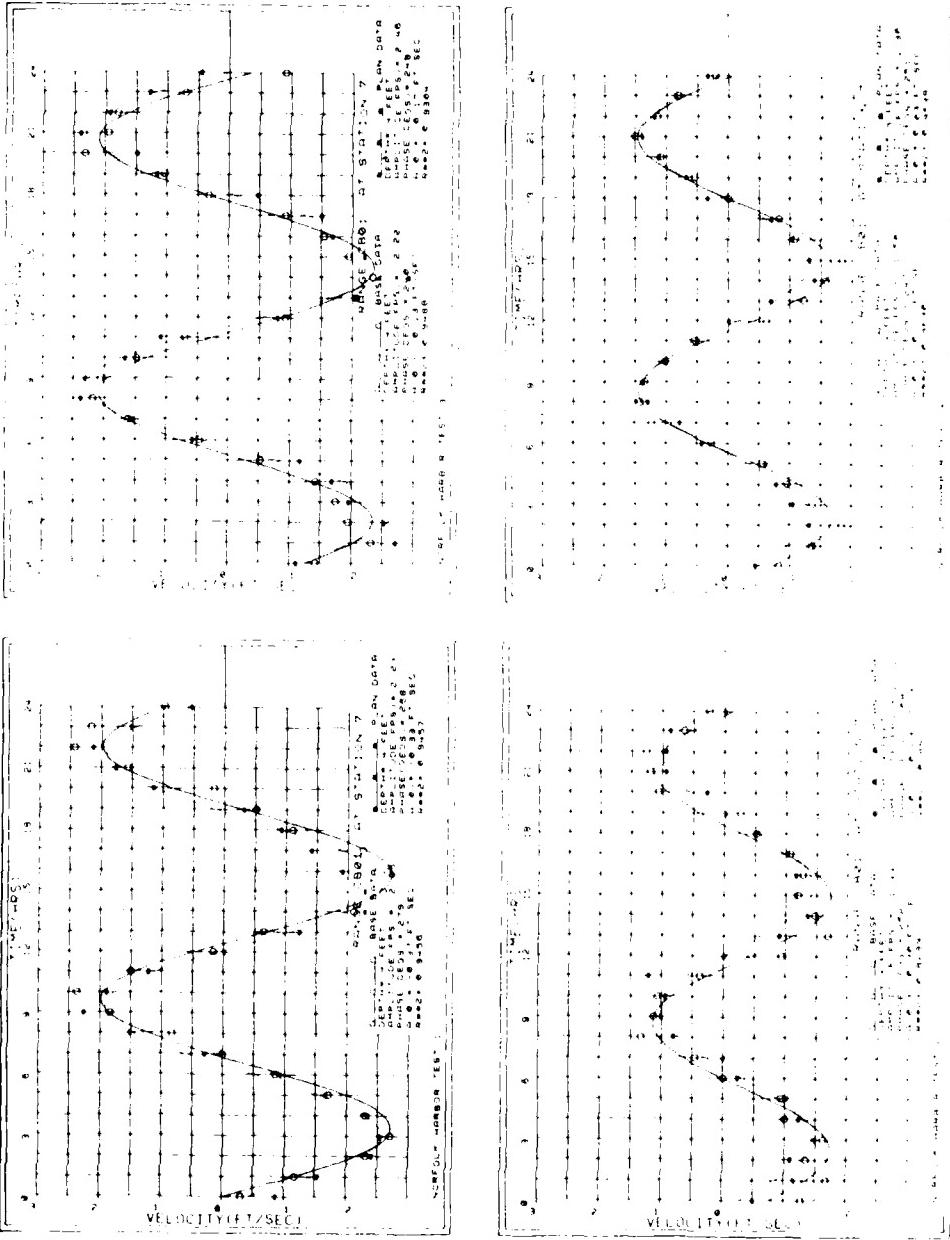


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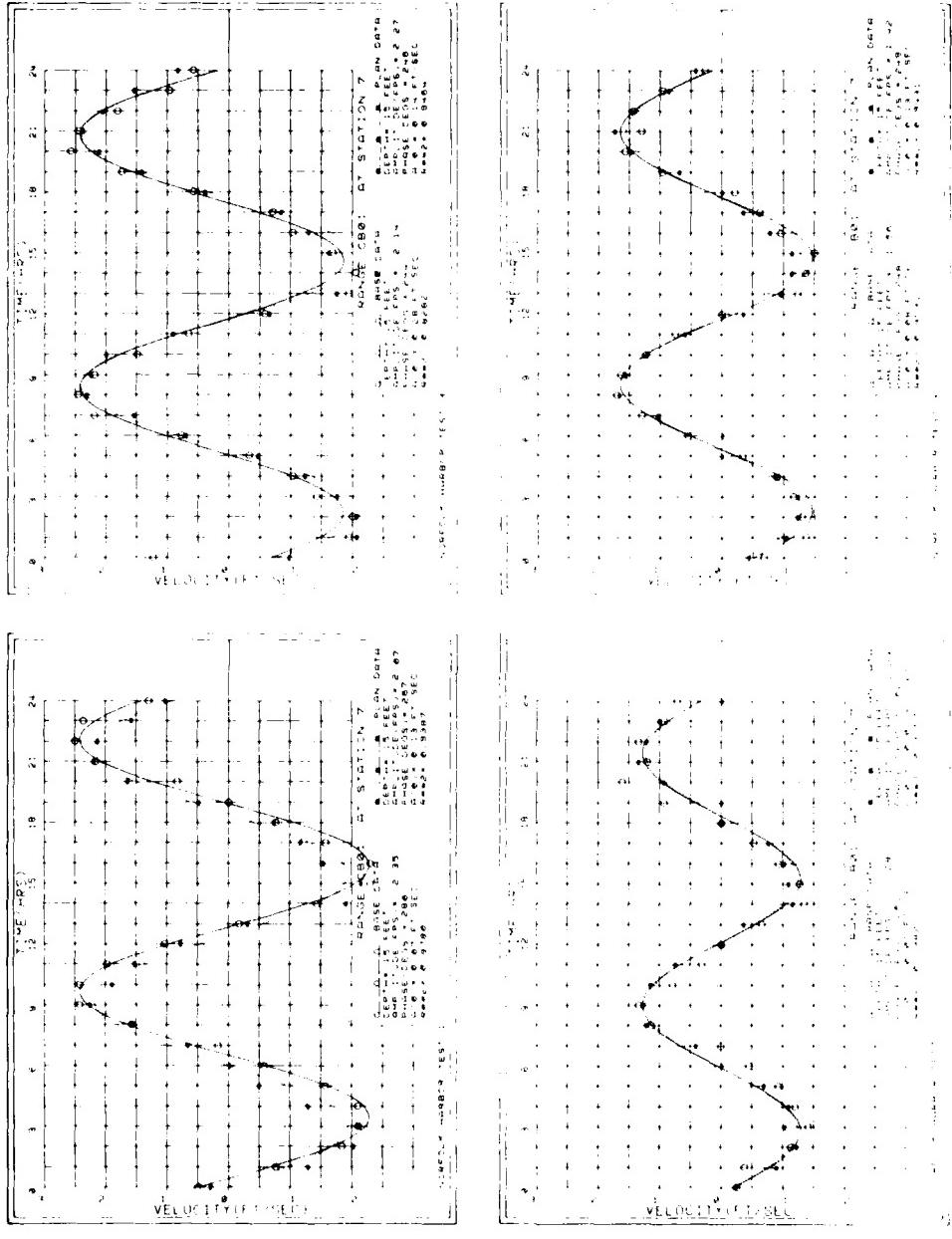


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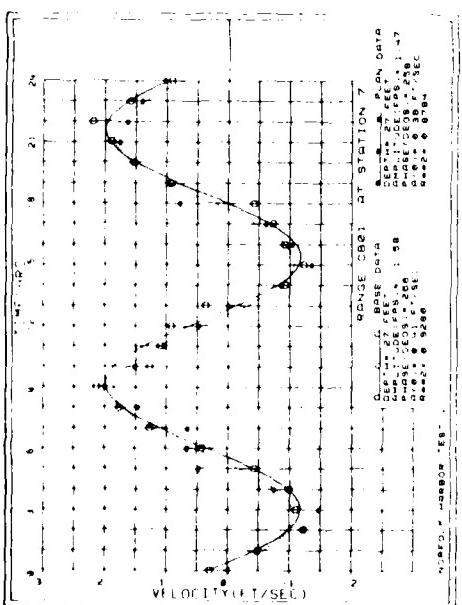
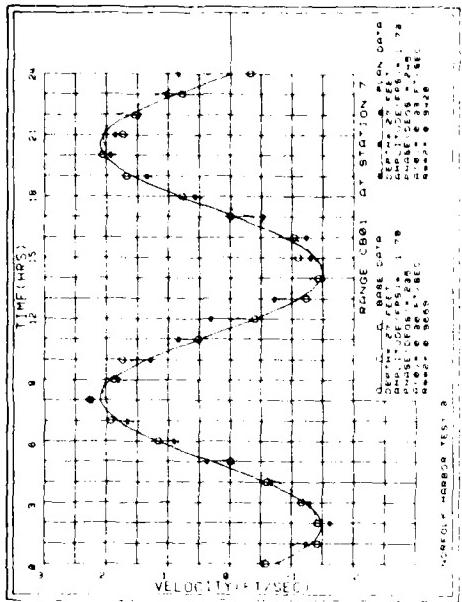


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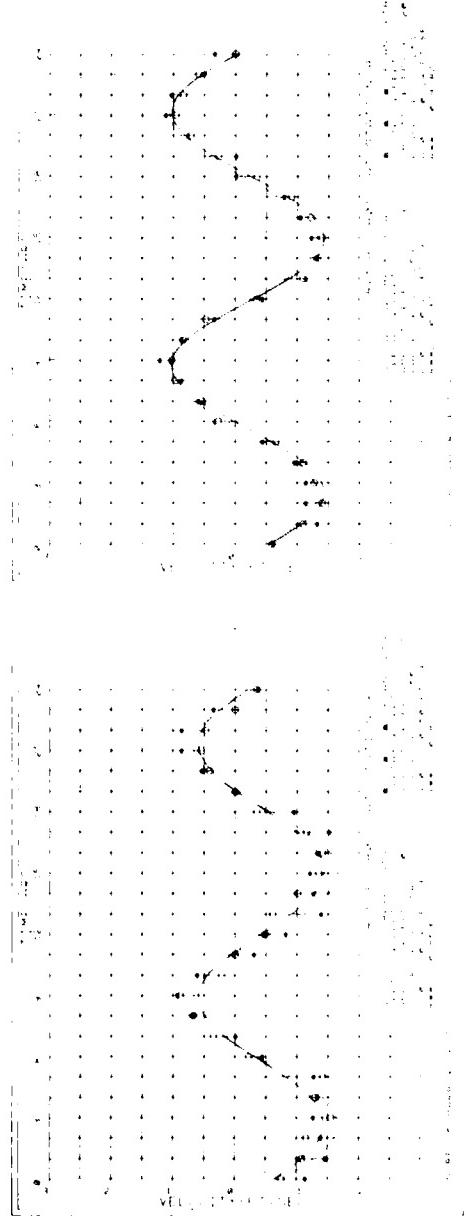
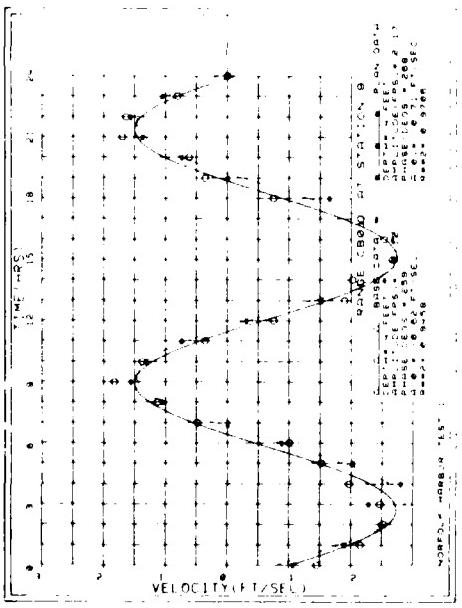
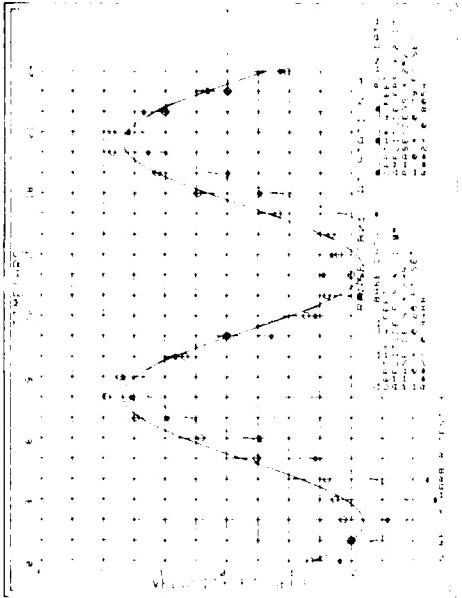


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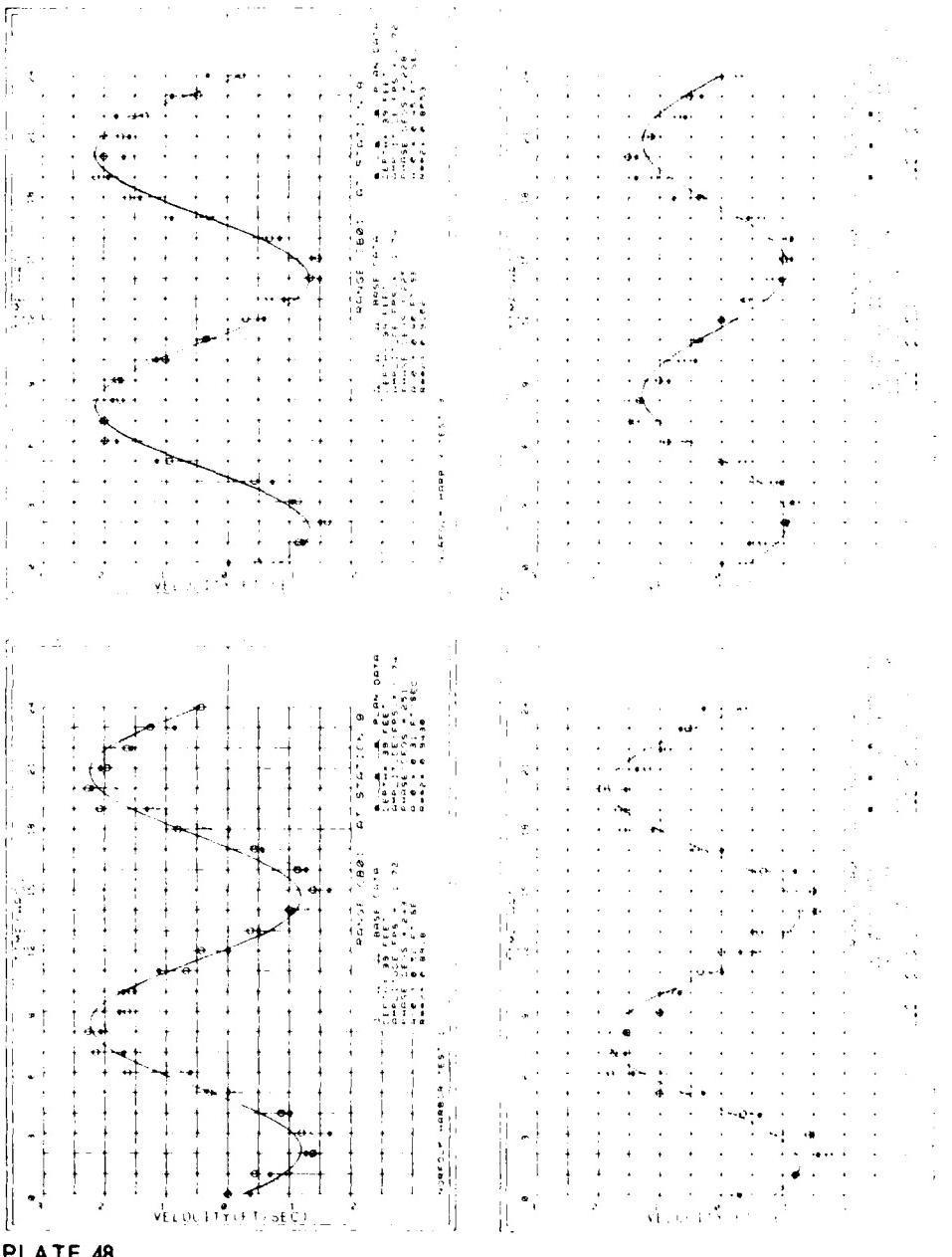


PLATE 48

PLATE 49

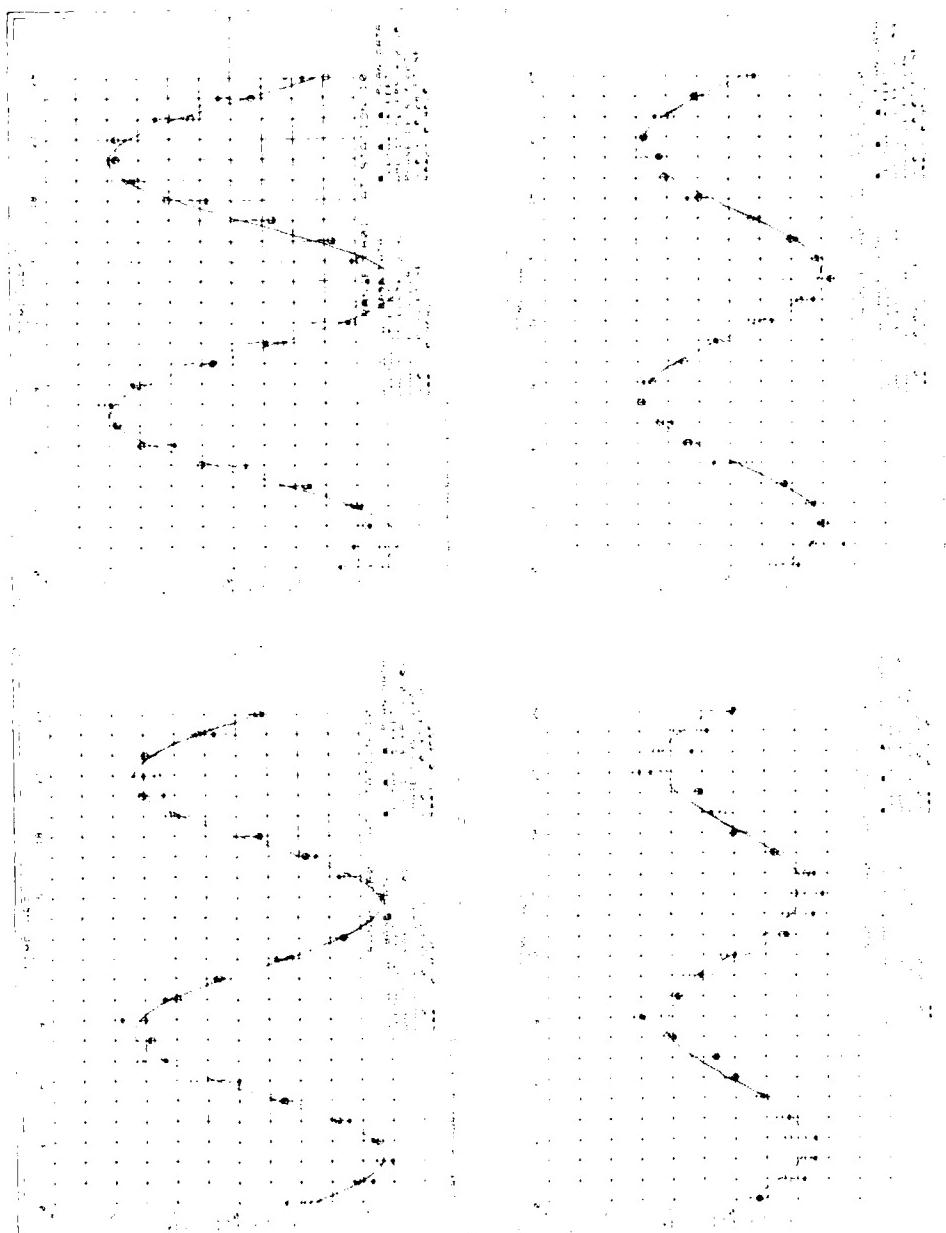


PLATE 50

PLATE 31

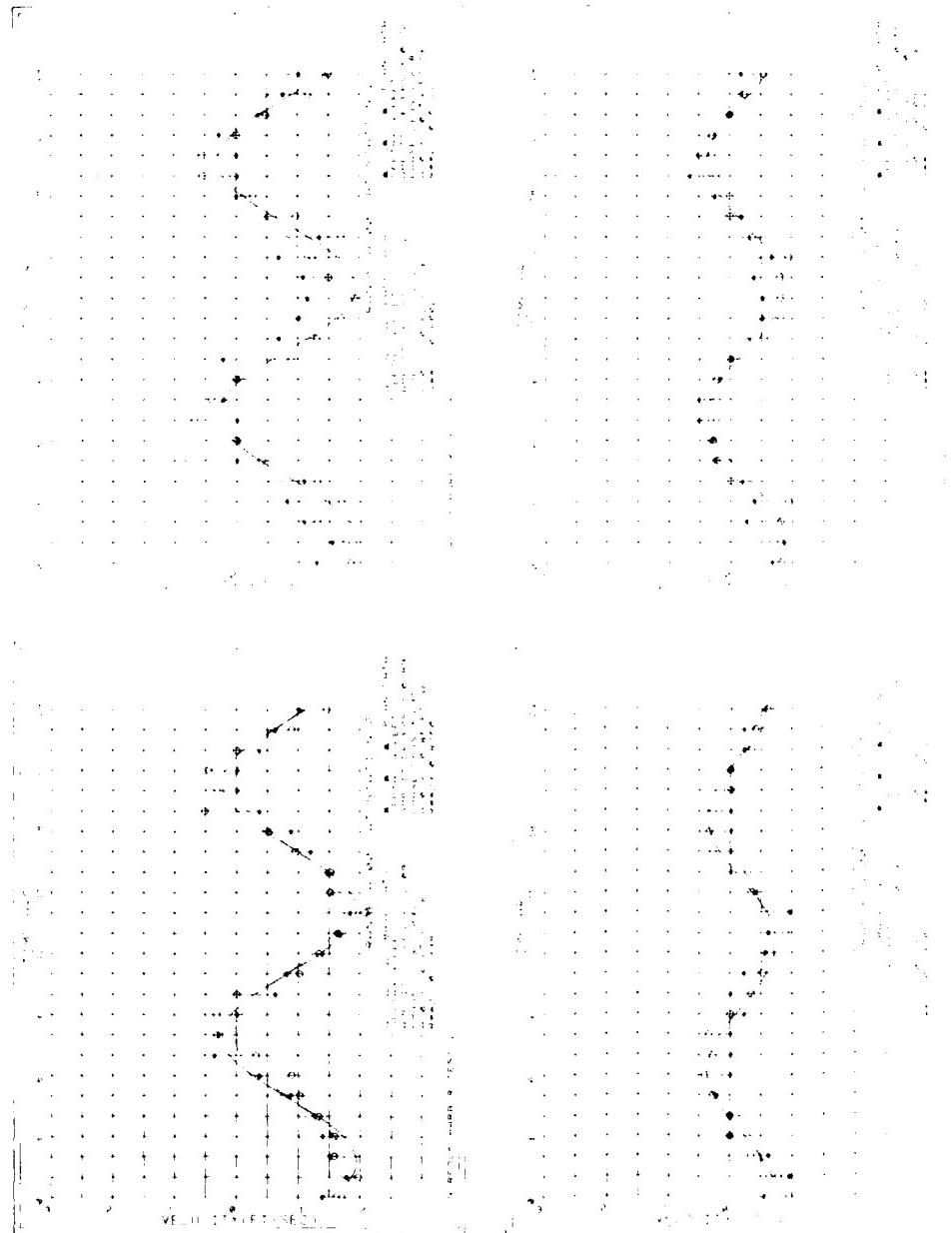


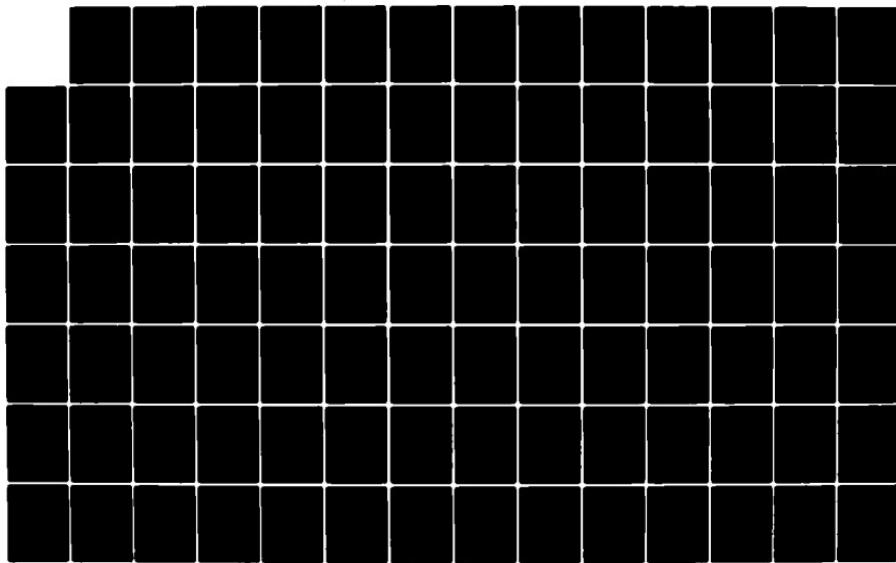
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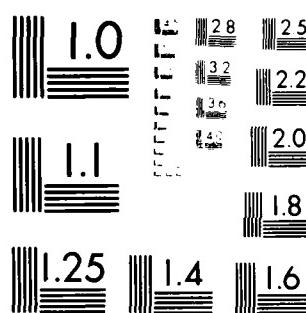
AD-A134 563 NORFOLK HARBOR AND CHANNELS DEEPENING STUDY REPORT 1
PHYSICAL MODEL RESUL..(U) ARMY ENGINEER WATERWAYS
EXPERIMENT STATION VICKSBURG MS HYDRA.

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MICROCOPY RESOLUTION TEST CHART
Nikon N.A. 1.00 A = 0.55 MM/0.0125 MM

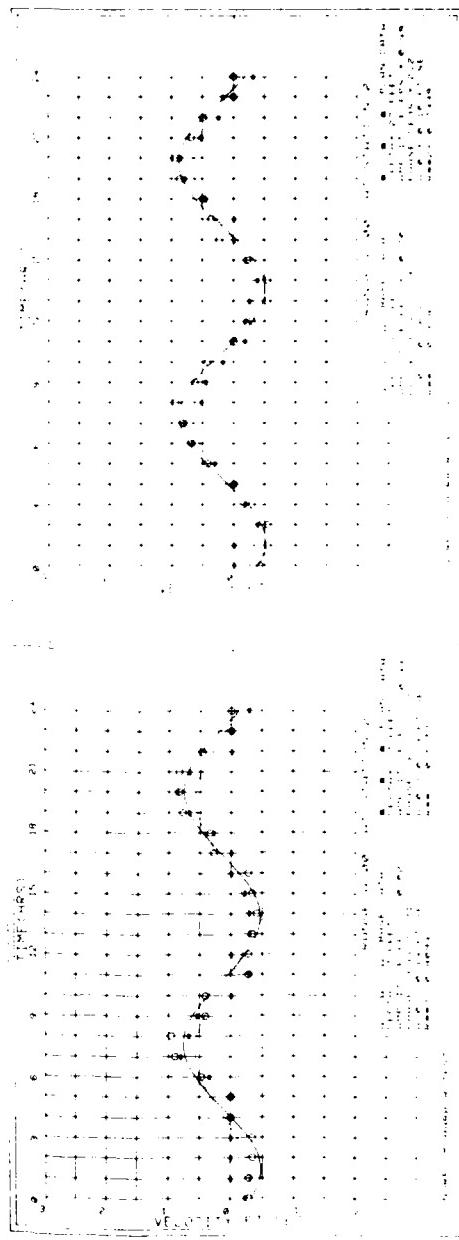
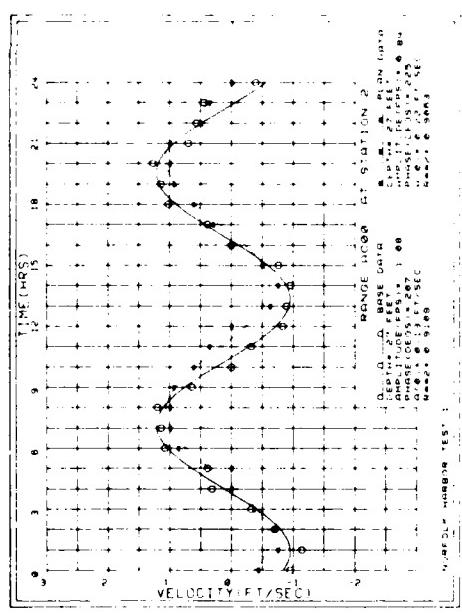
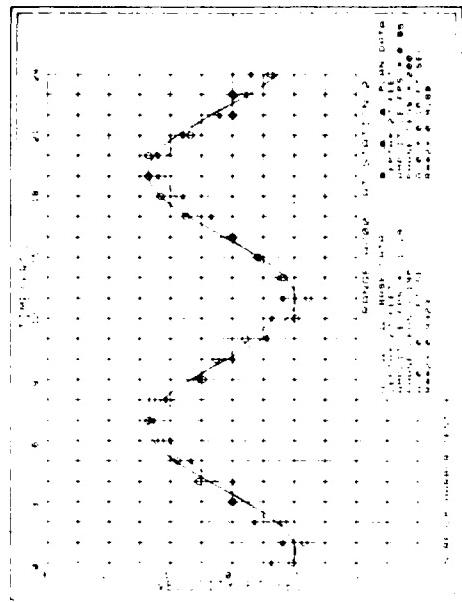


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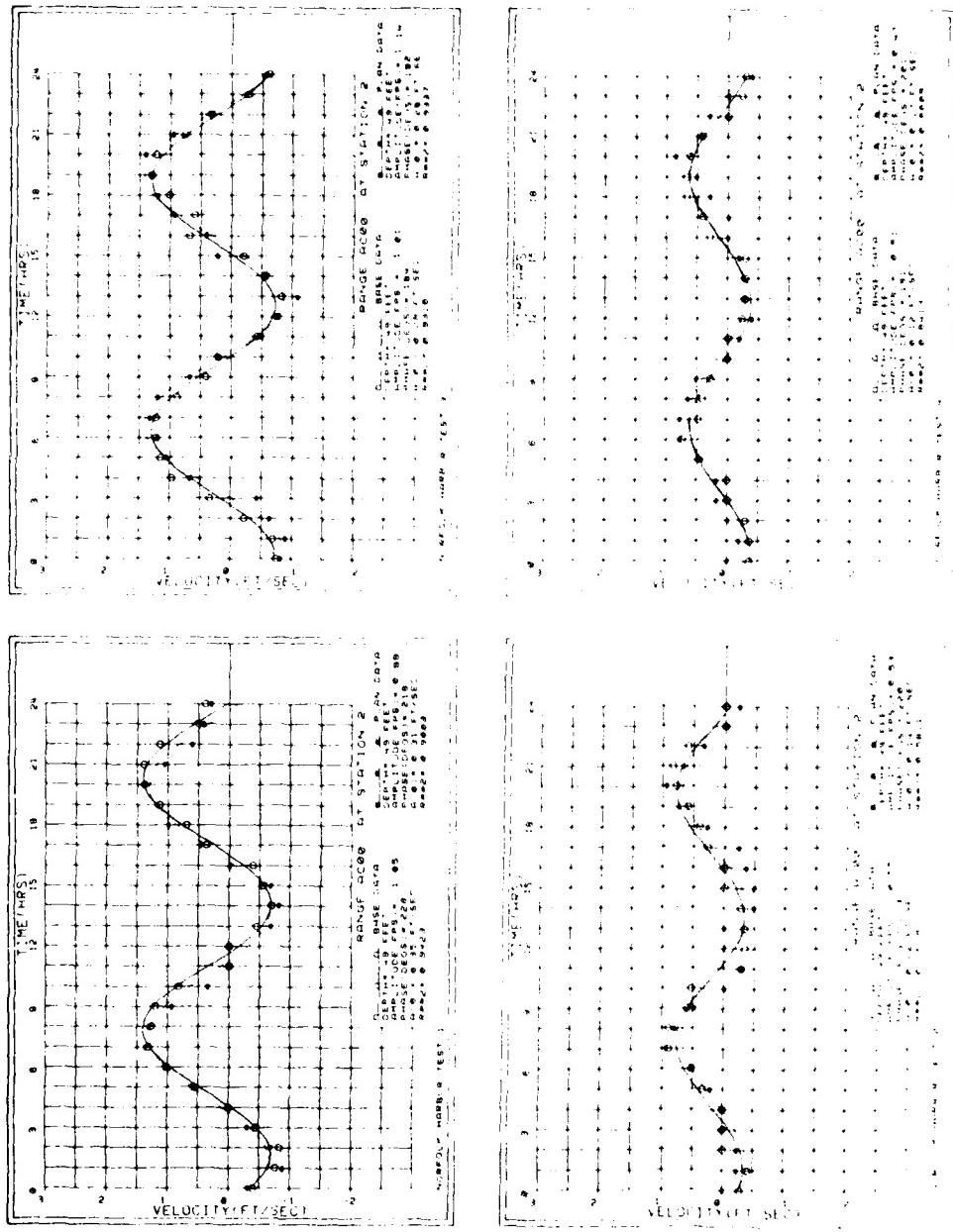


PLATE 54

PLATE 55

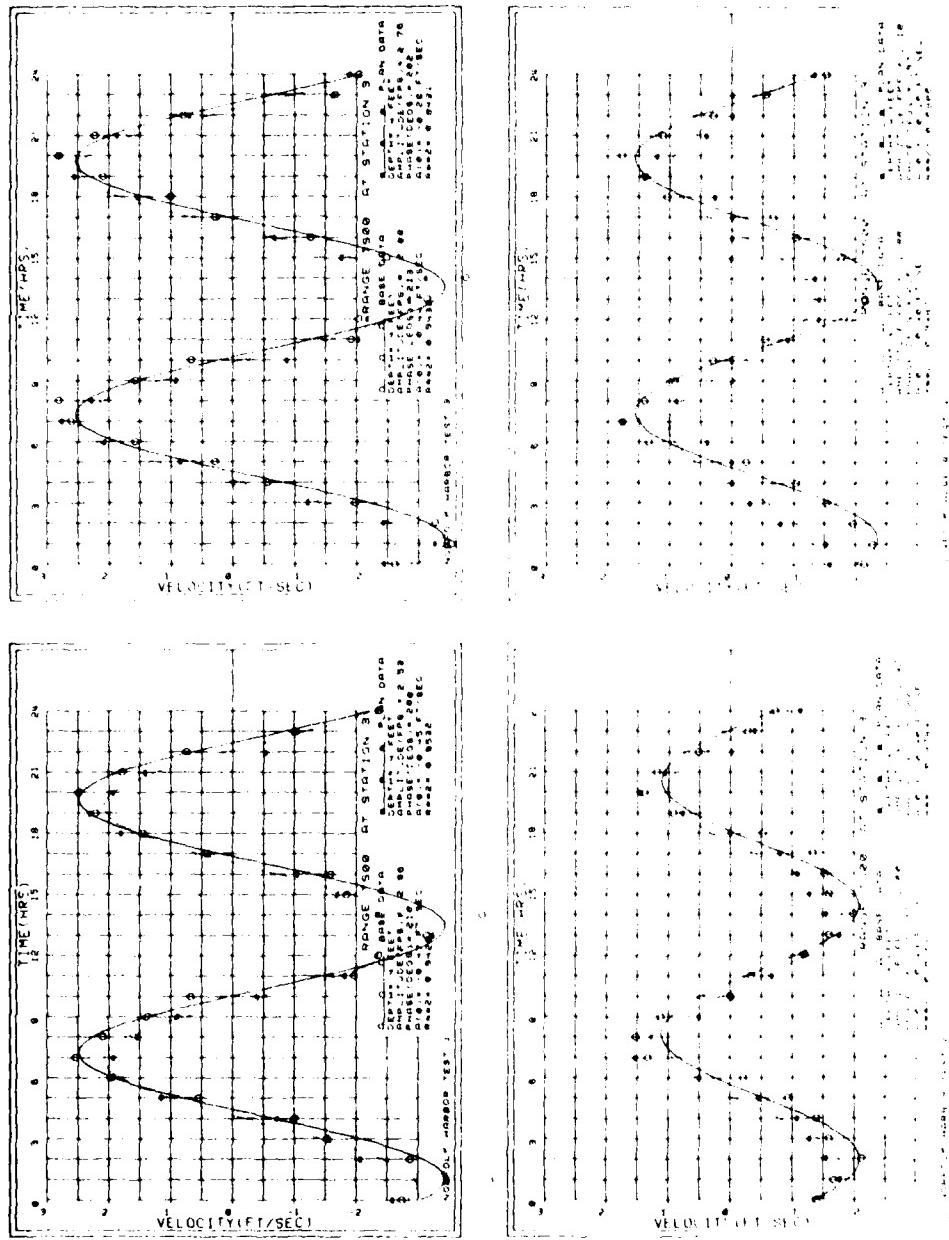


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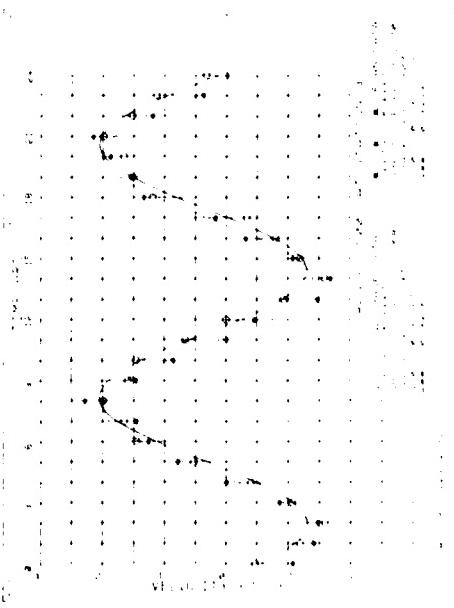
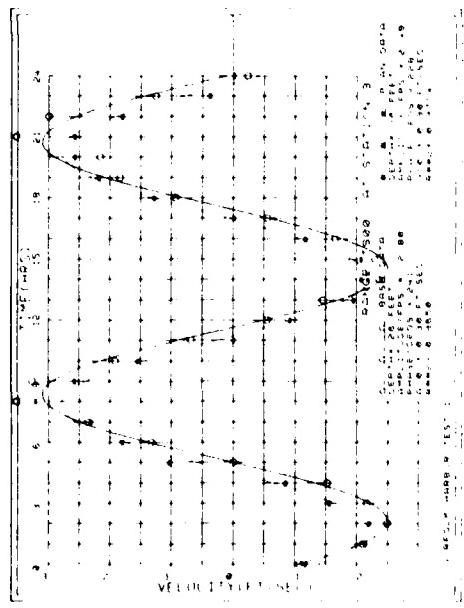
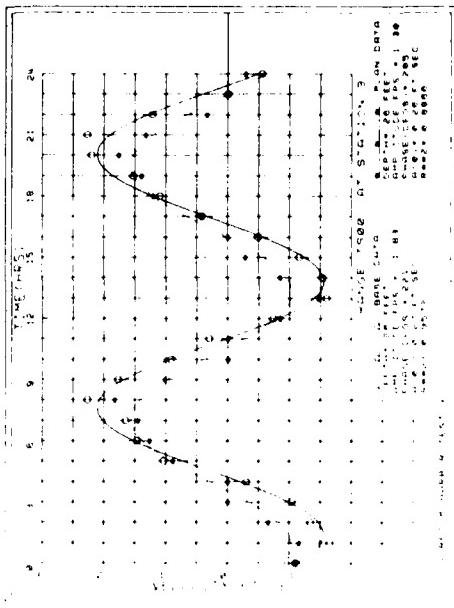
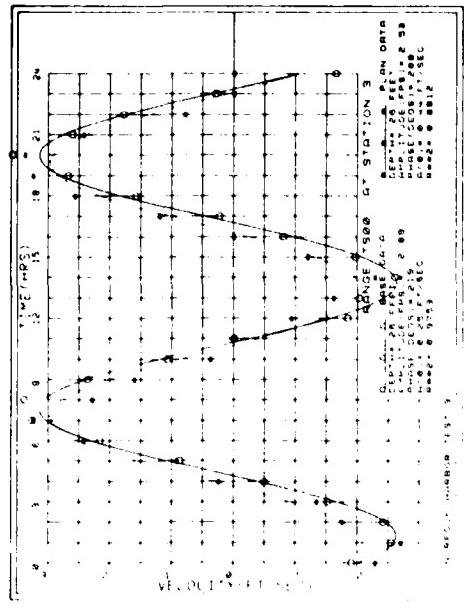


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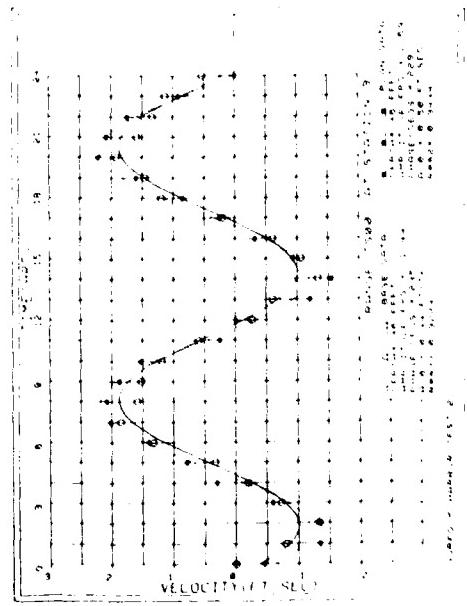
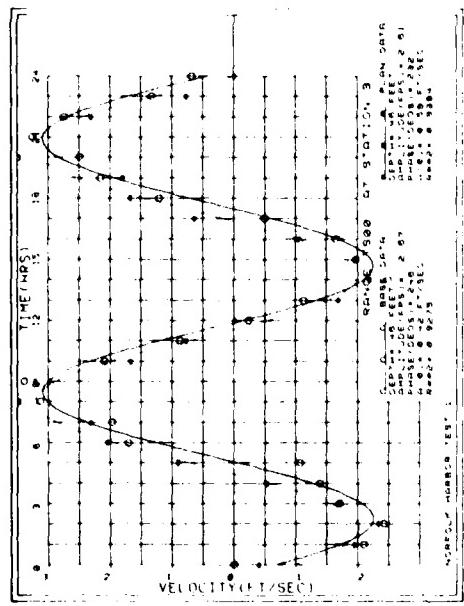
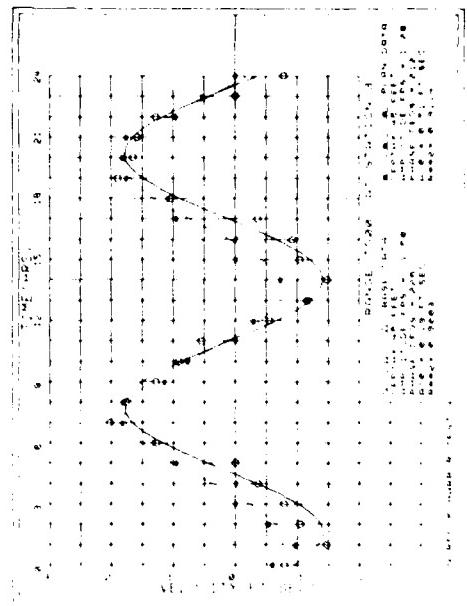
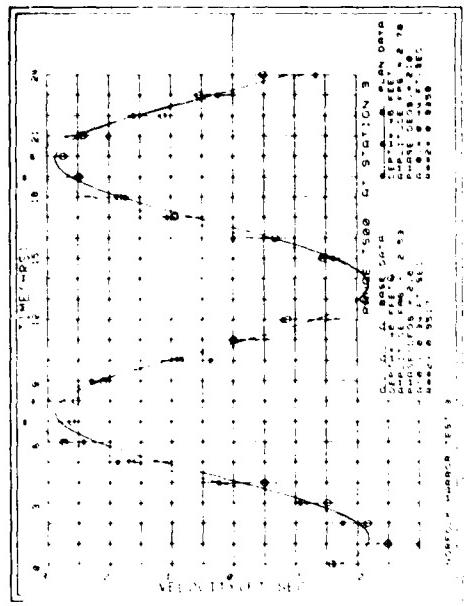


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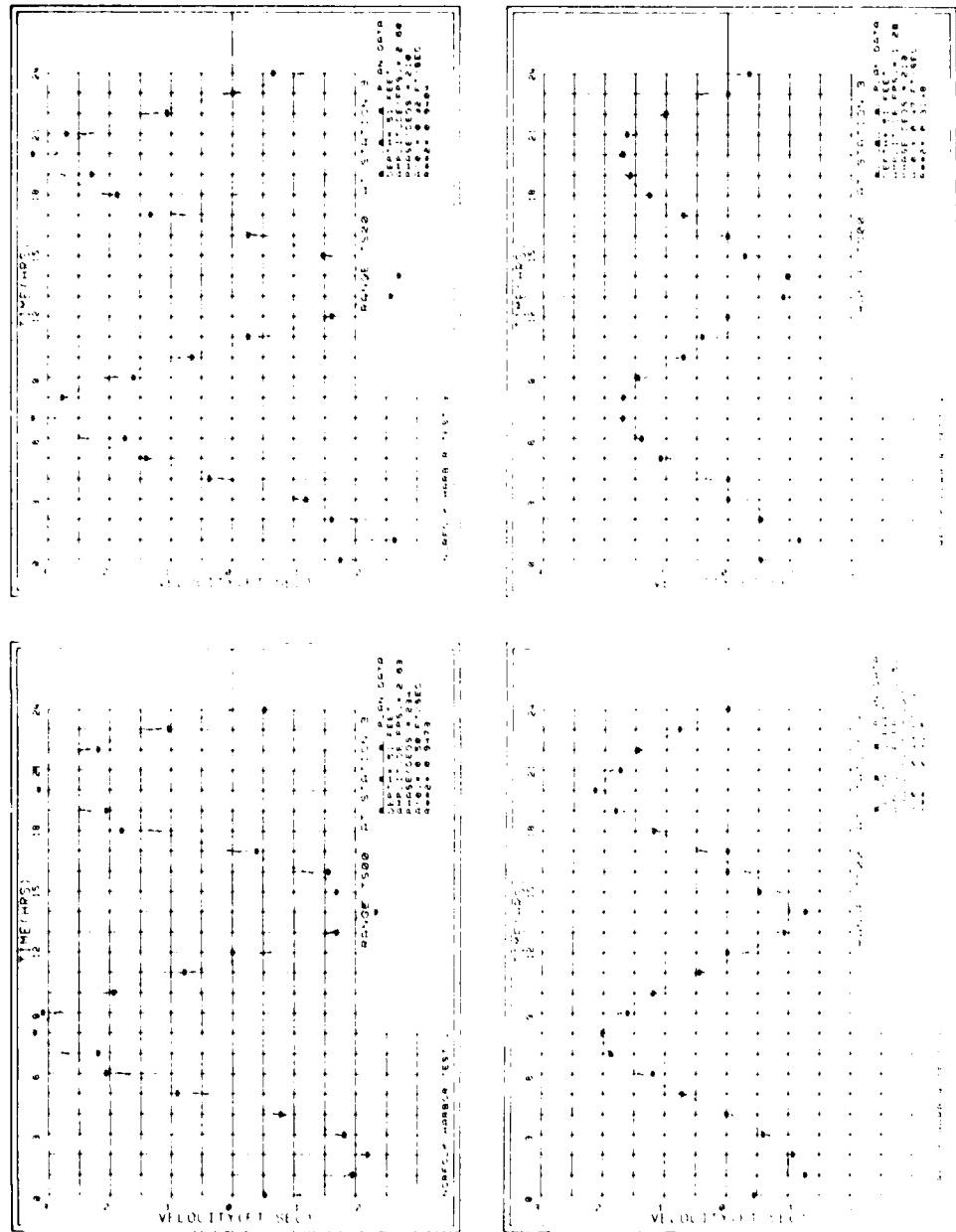


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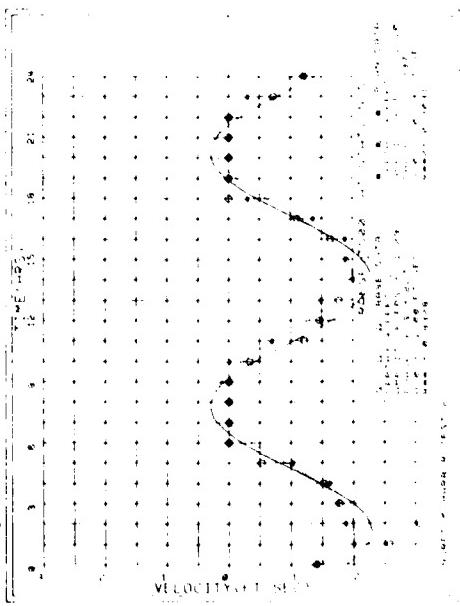
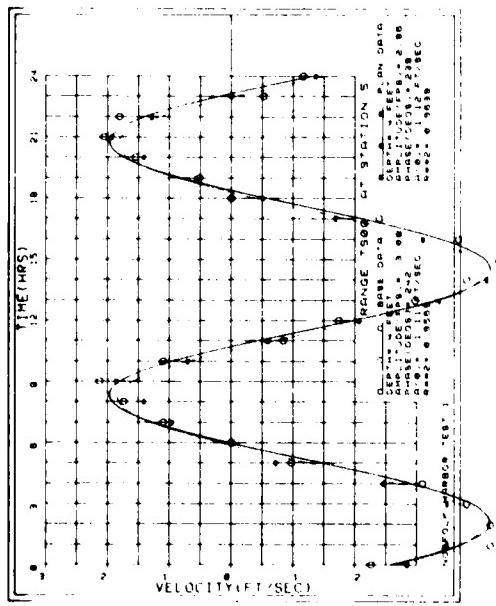
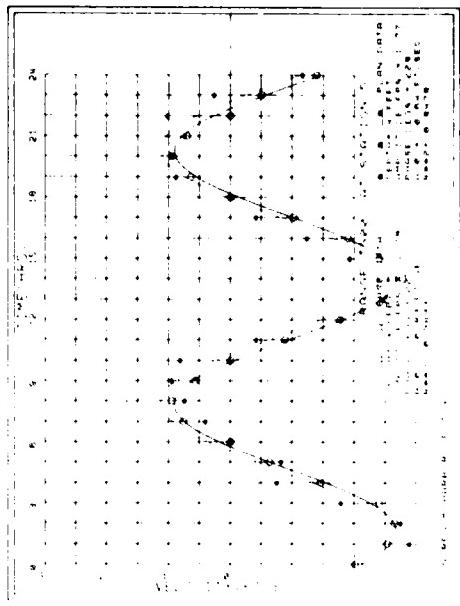
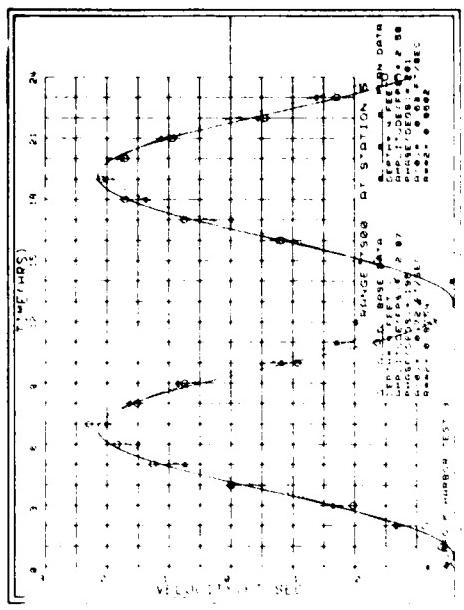


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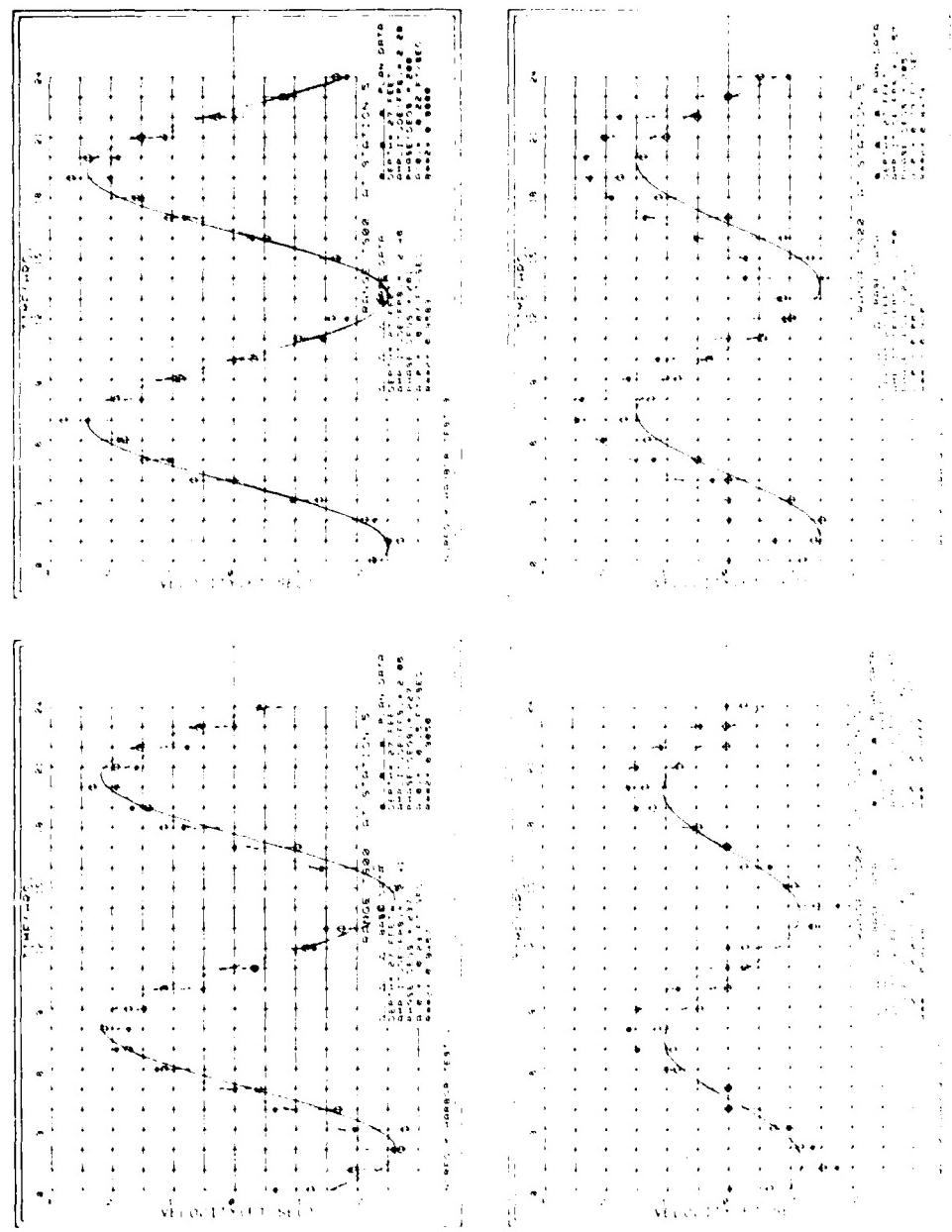
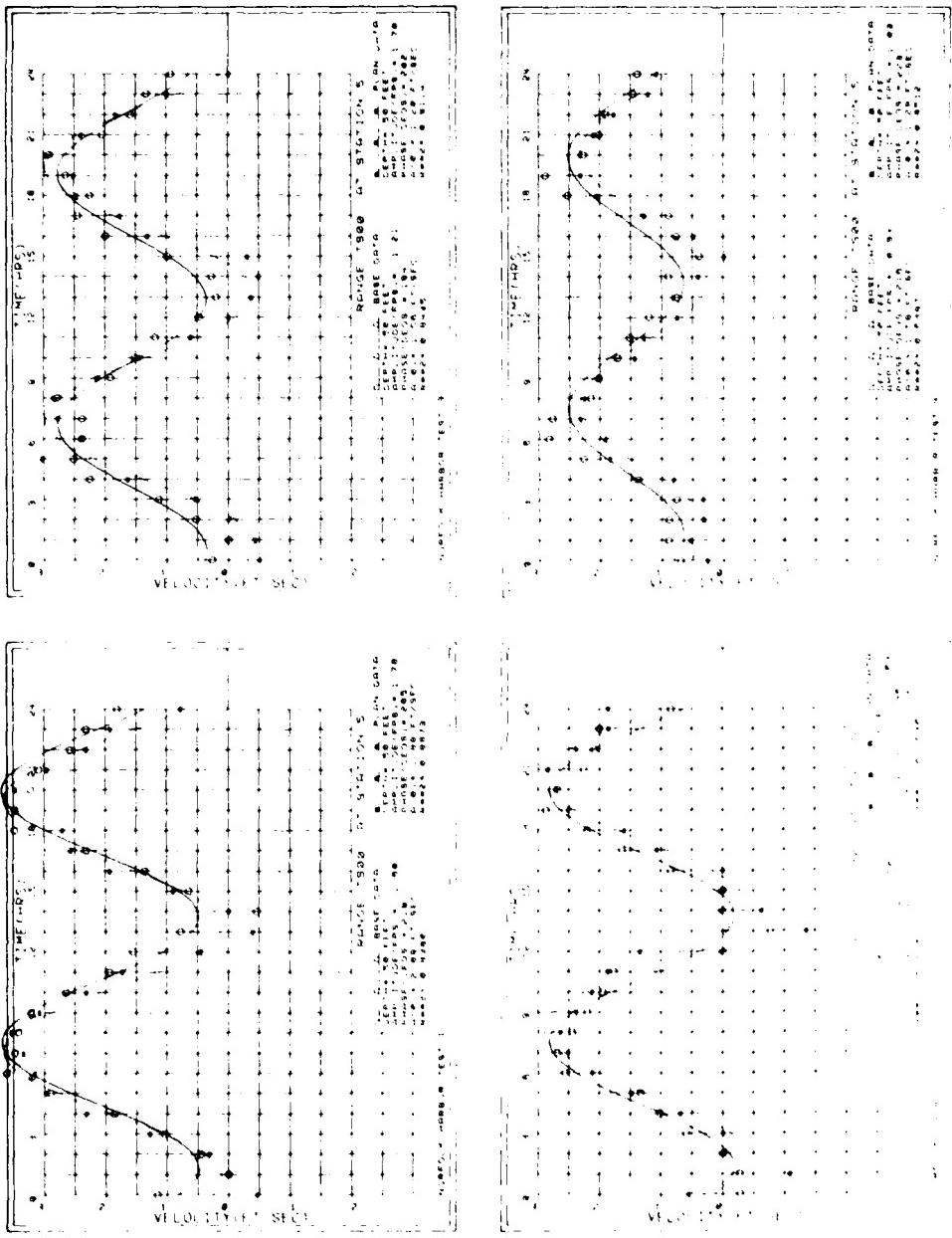


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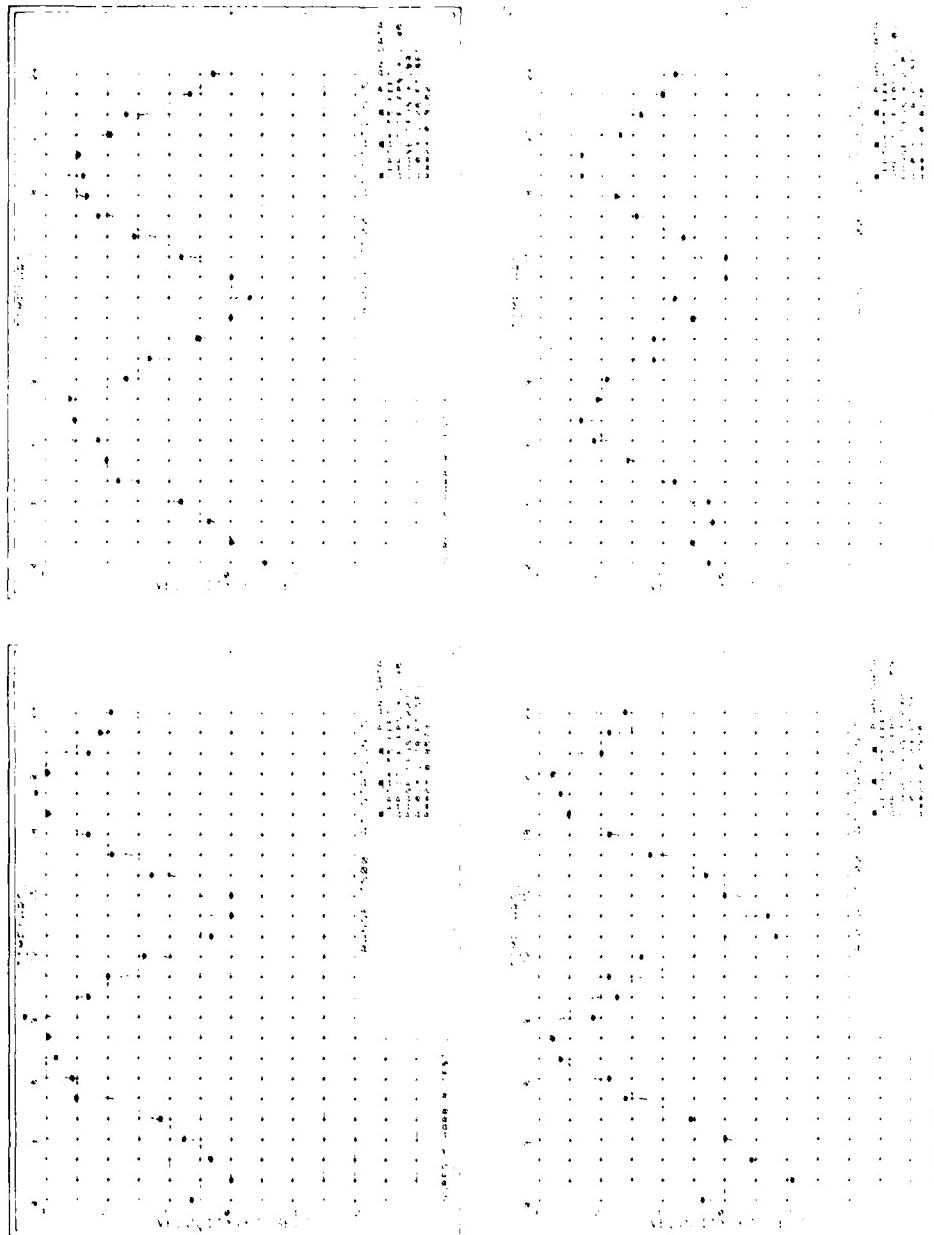


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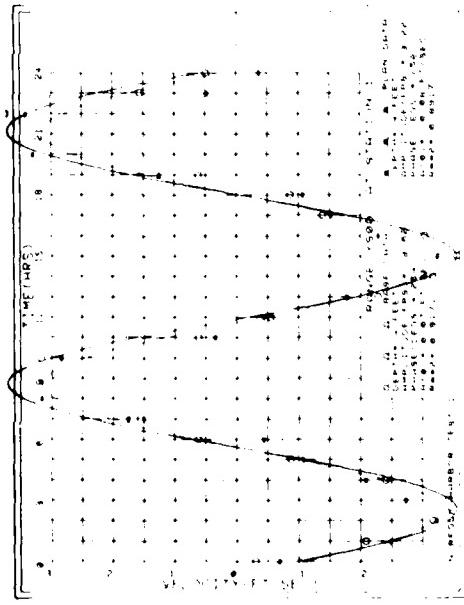
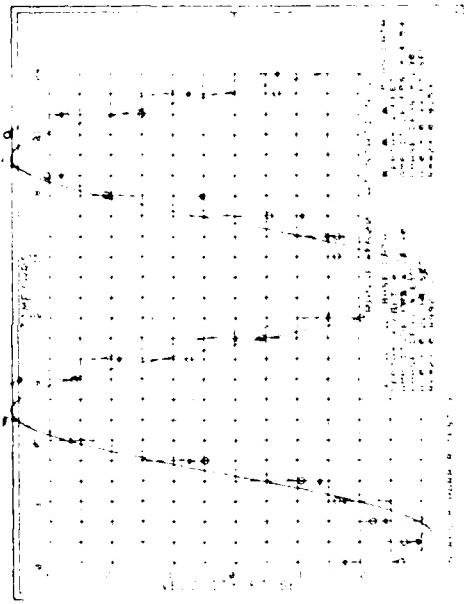


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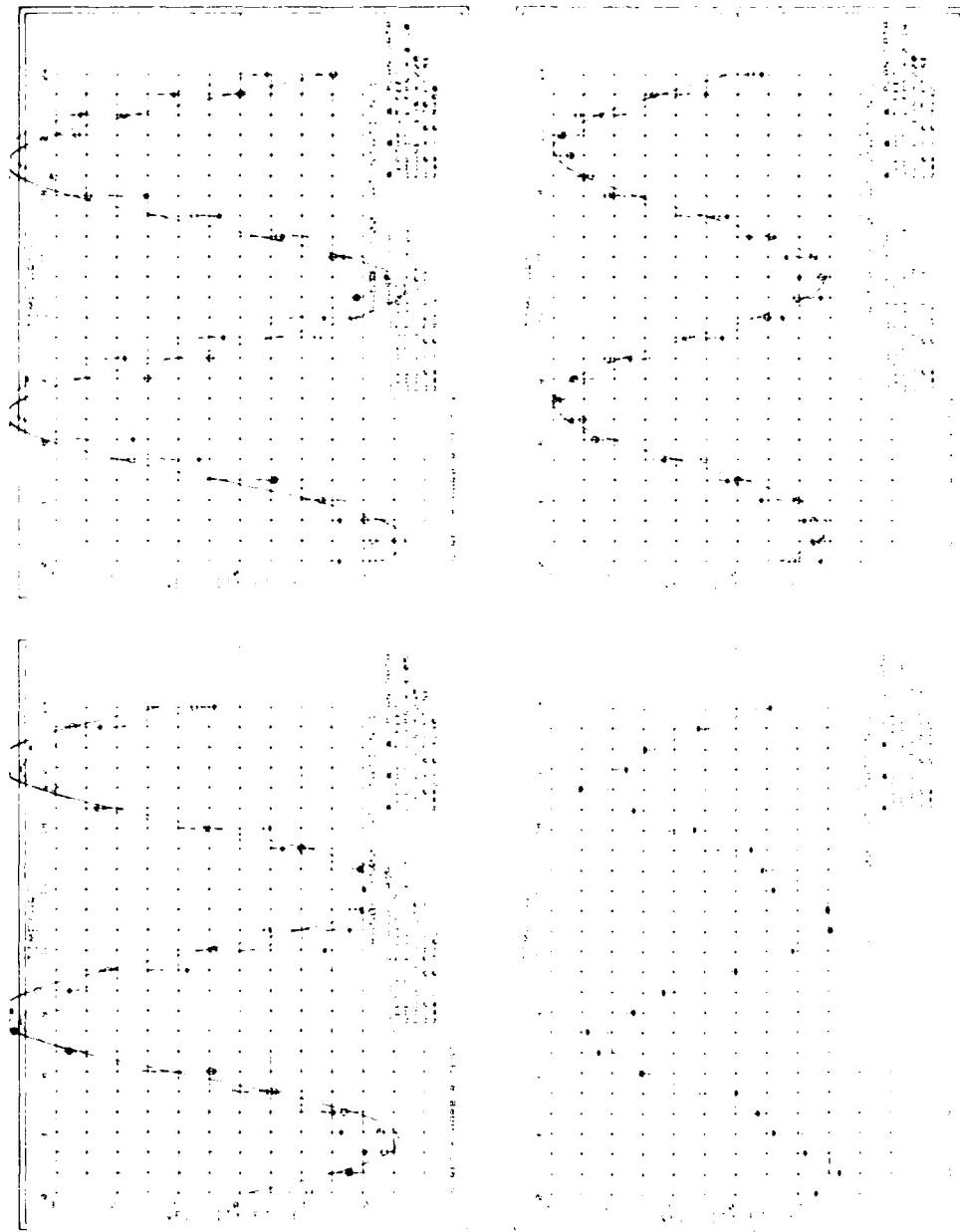


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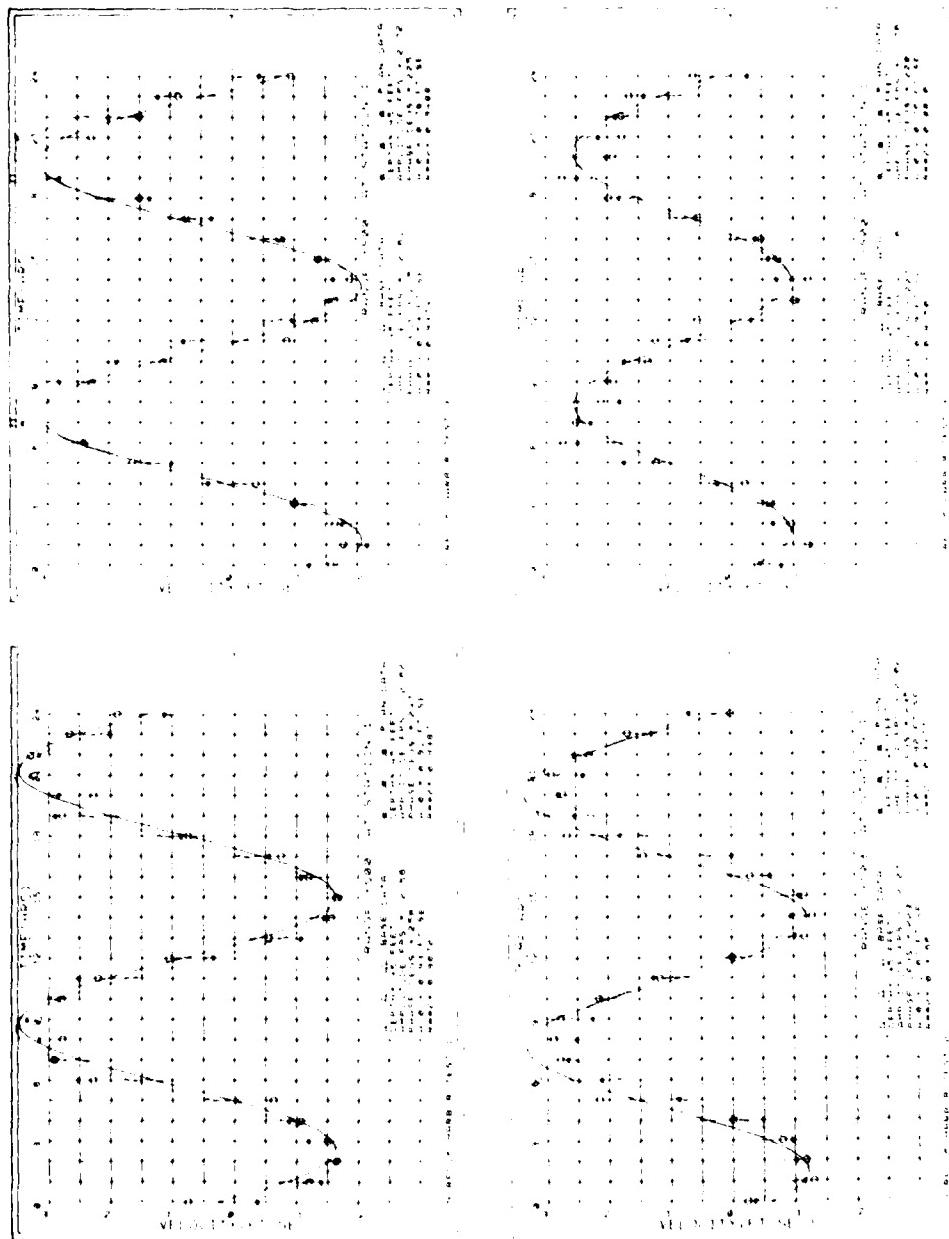


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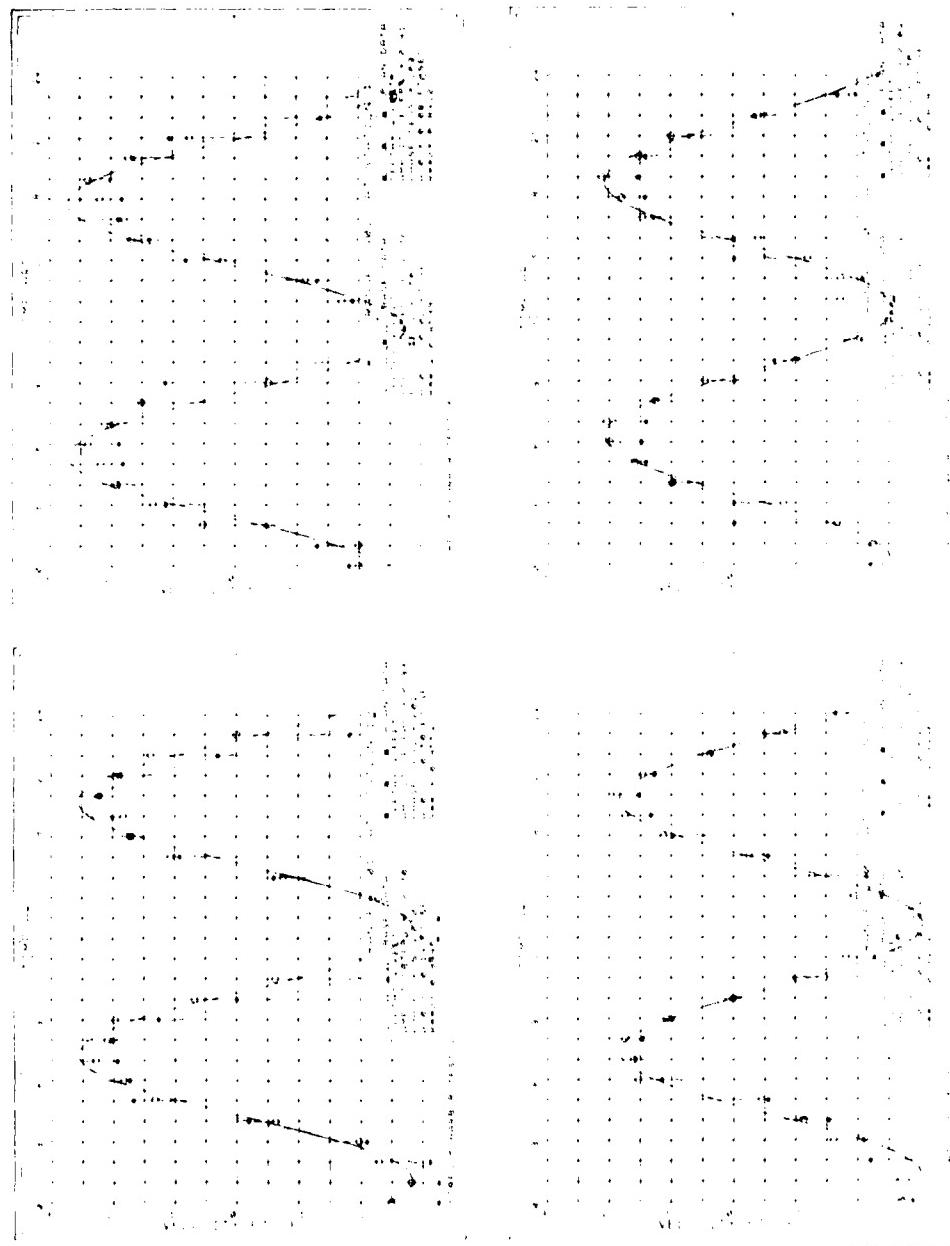


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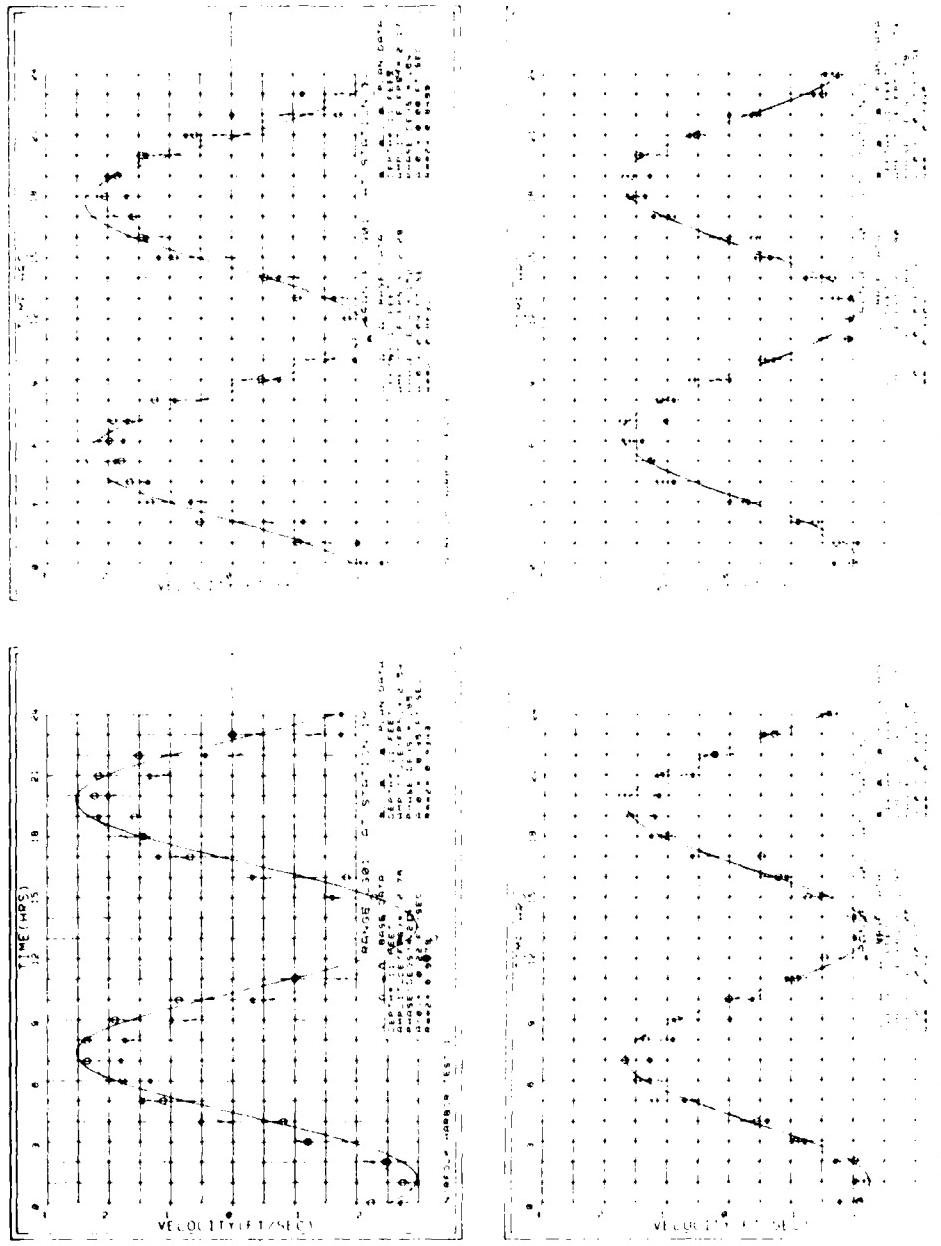


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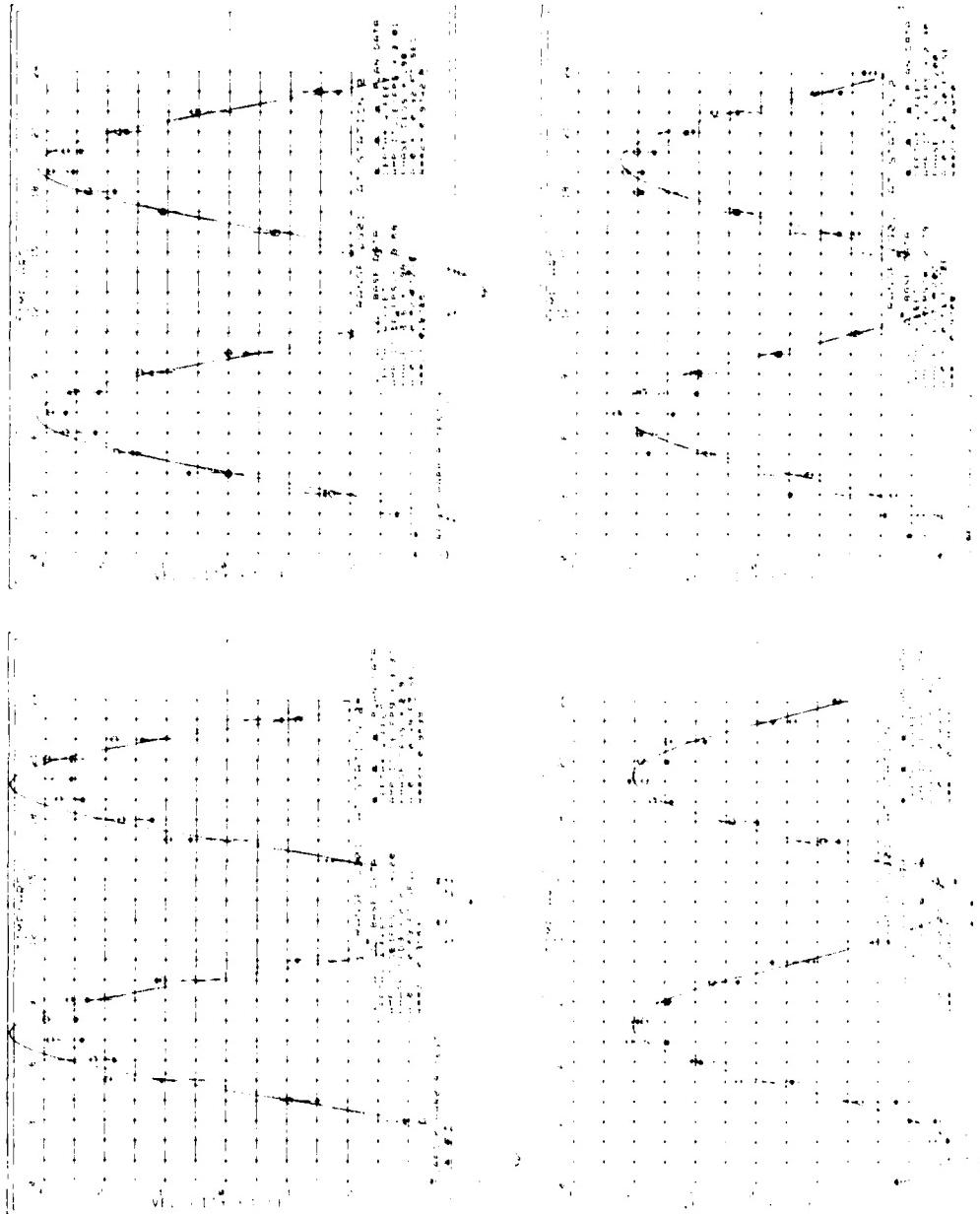


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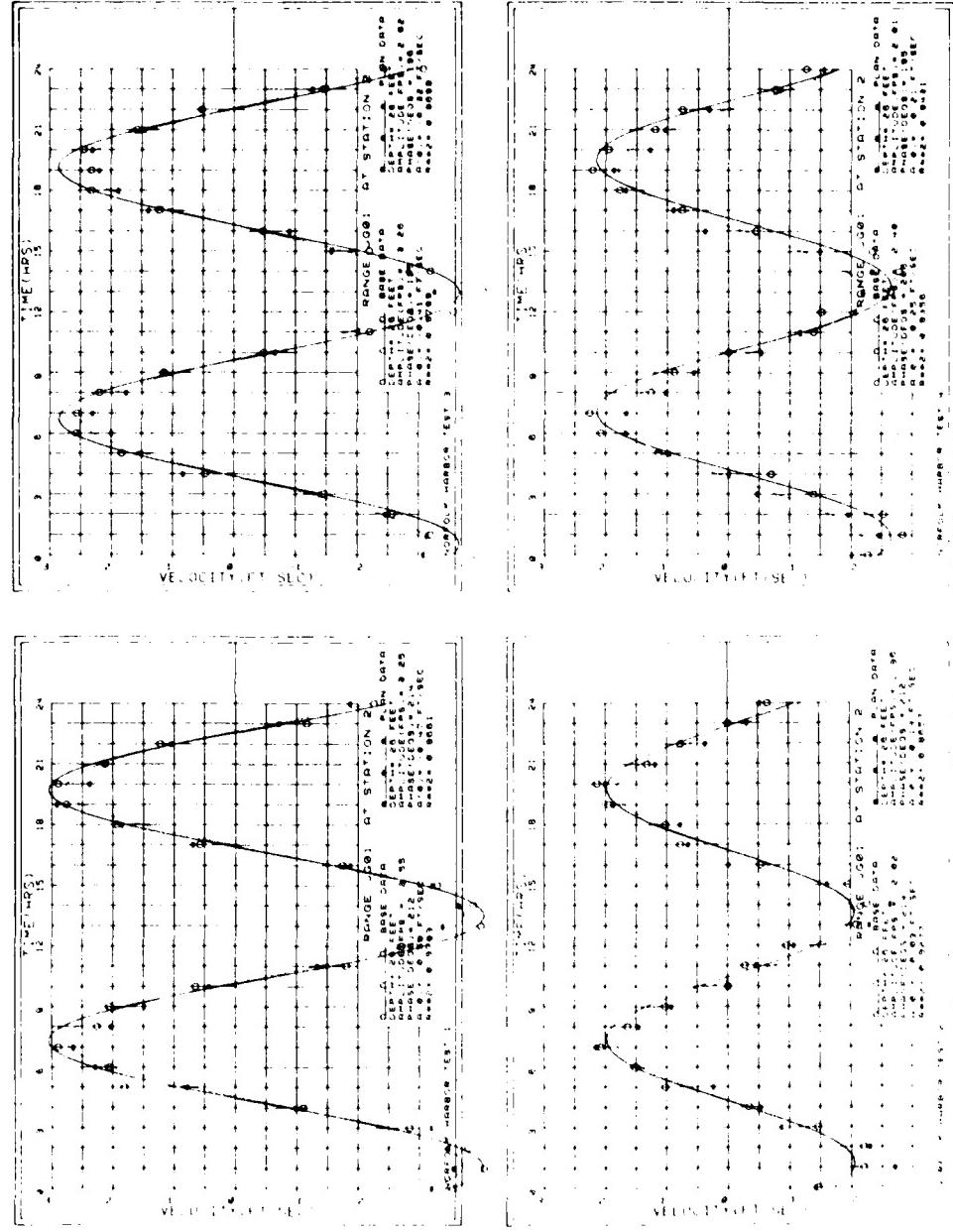


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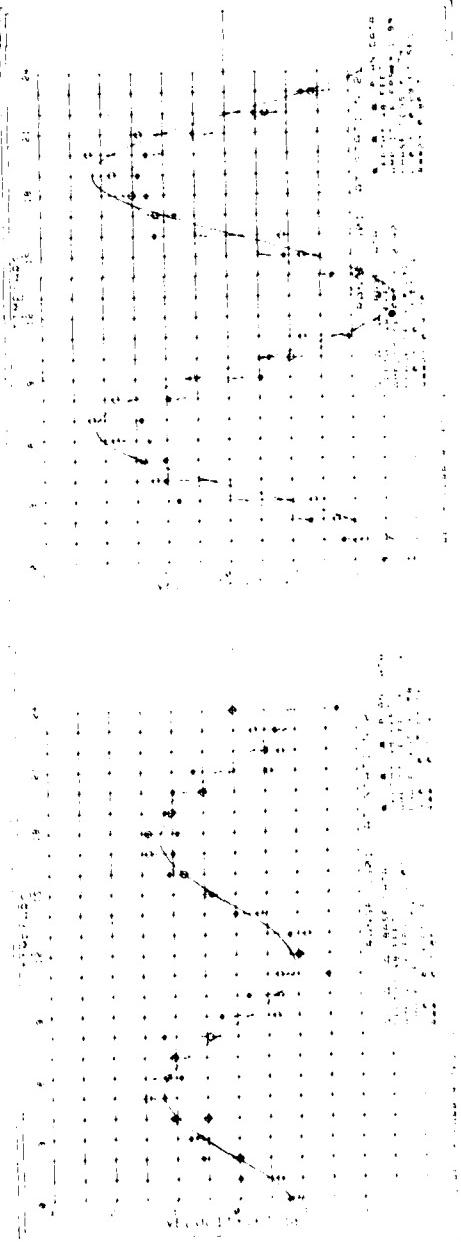
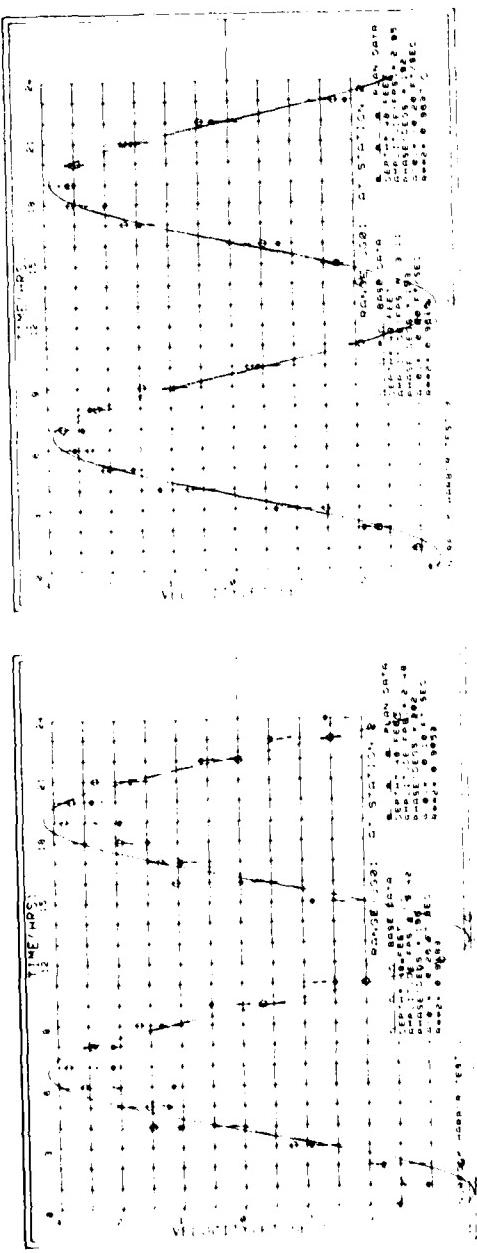


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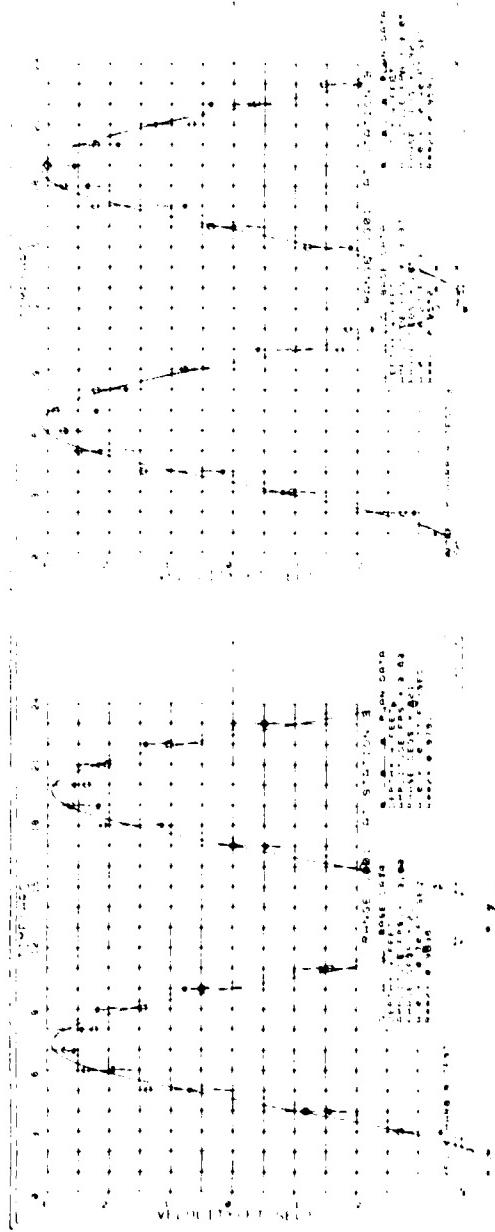
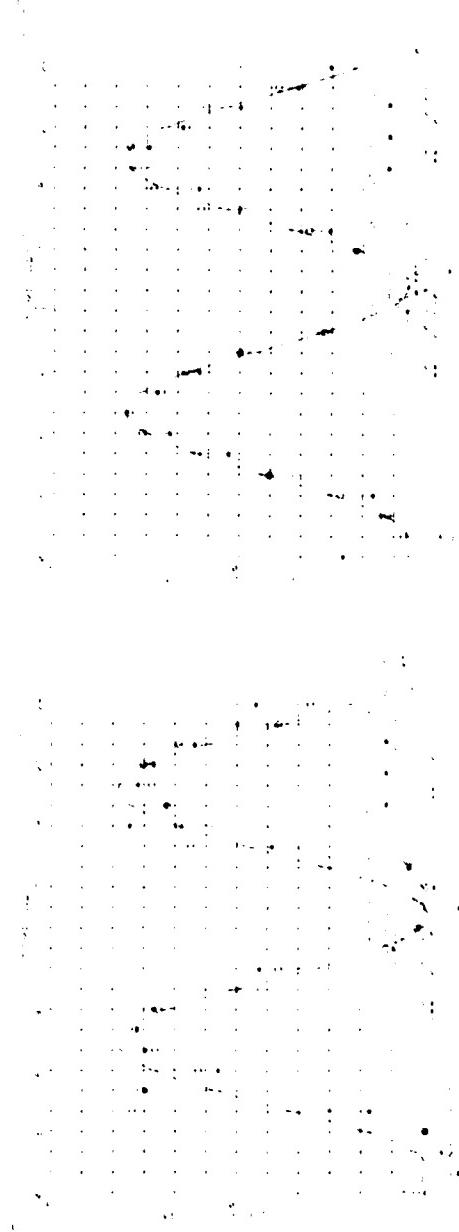


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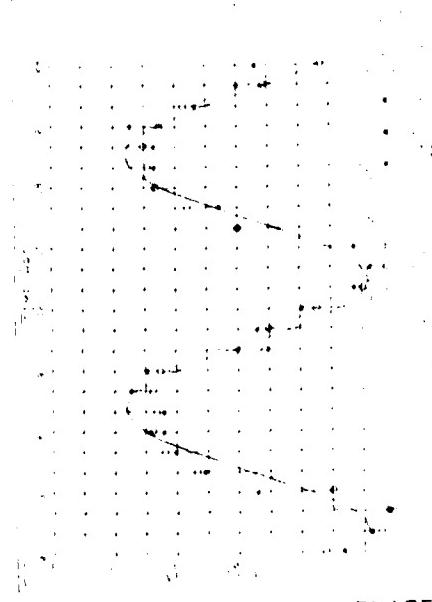
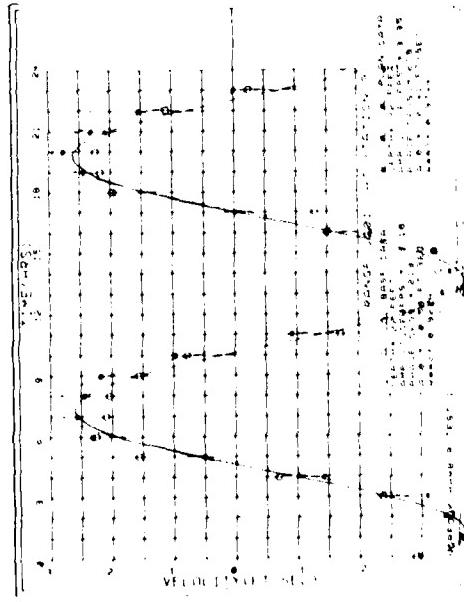
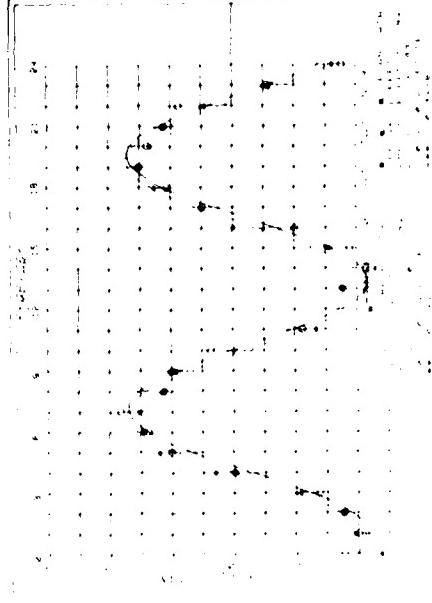
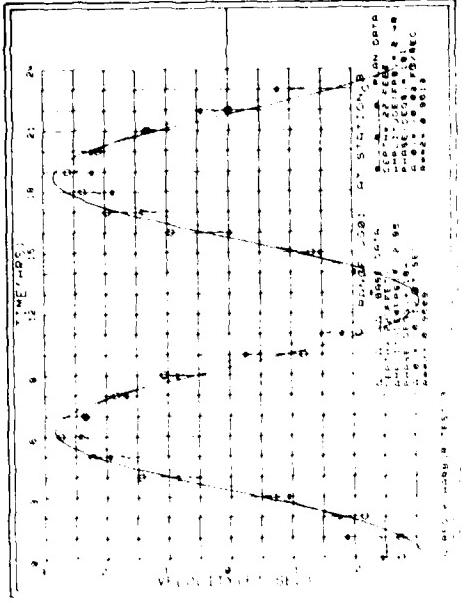


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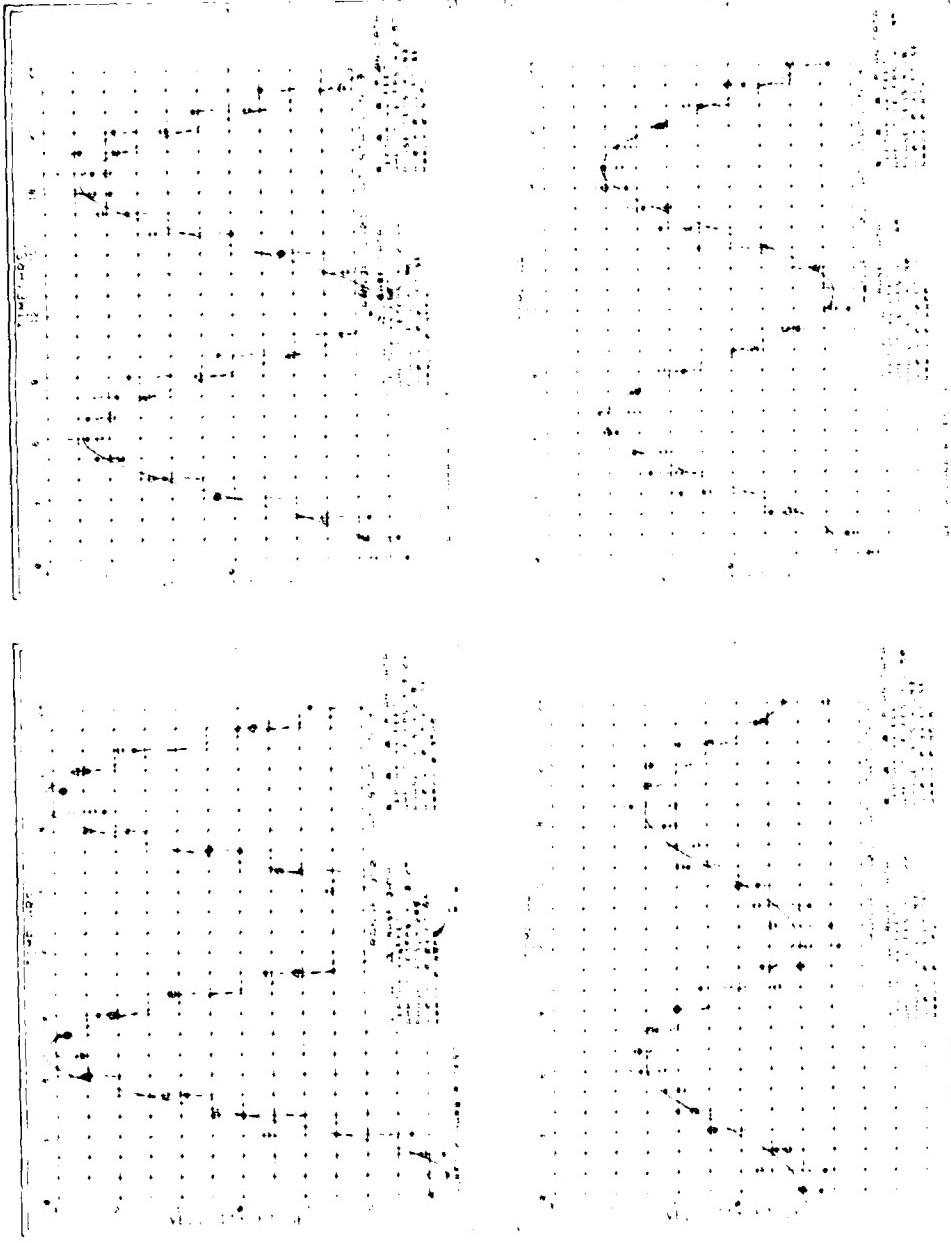


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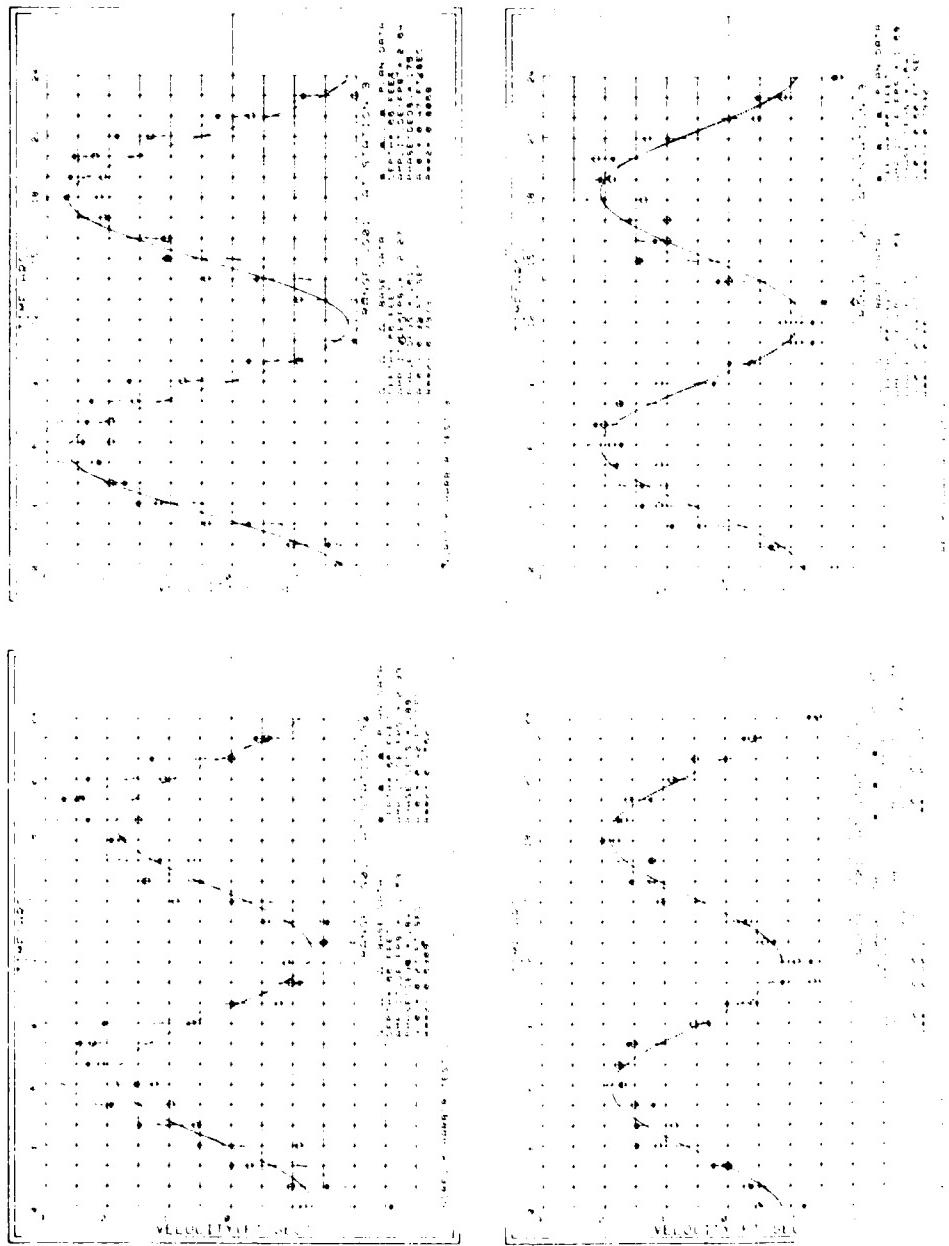


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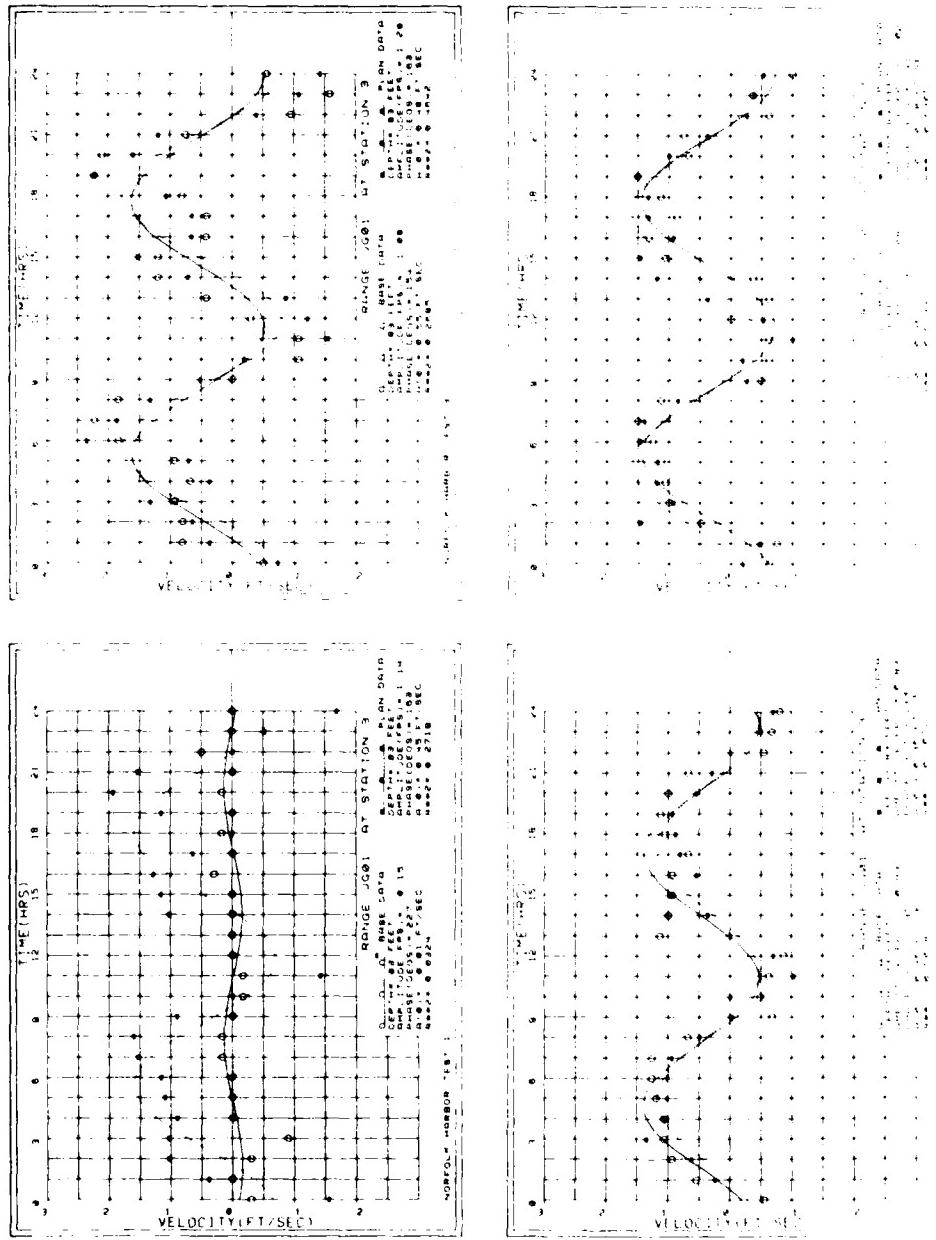


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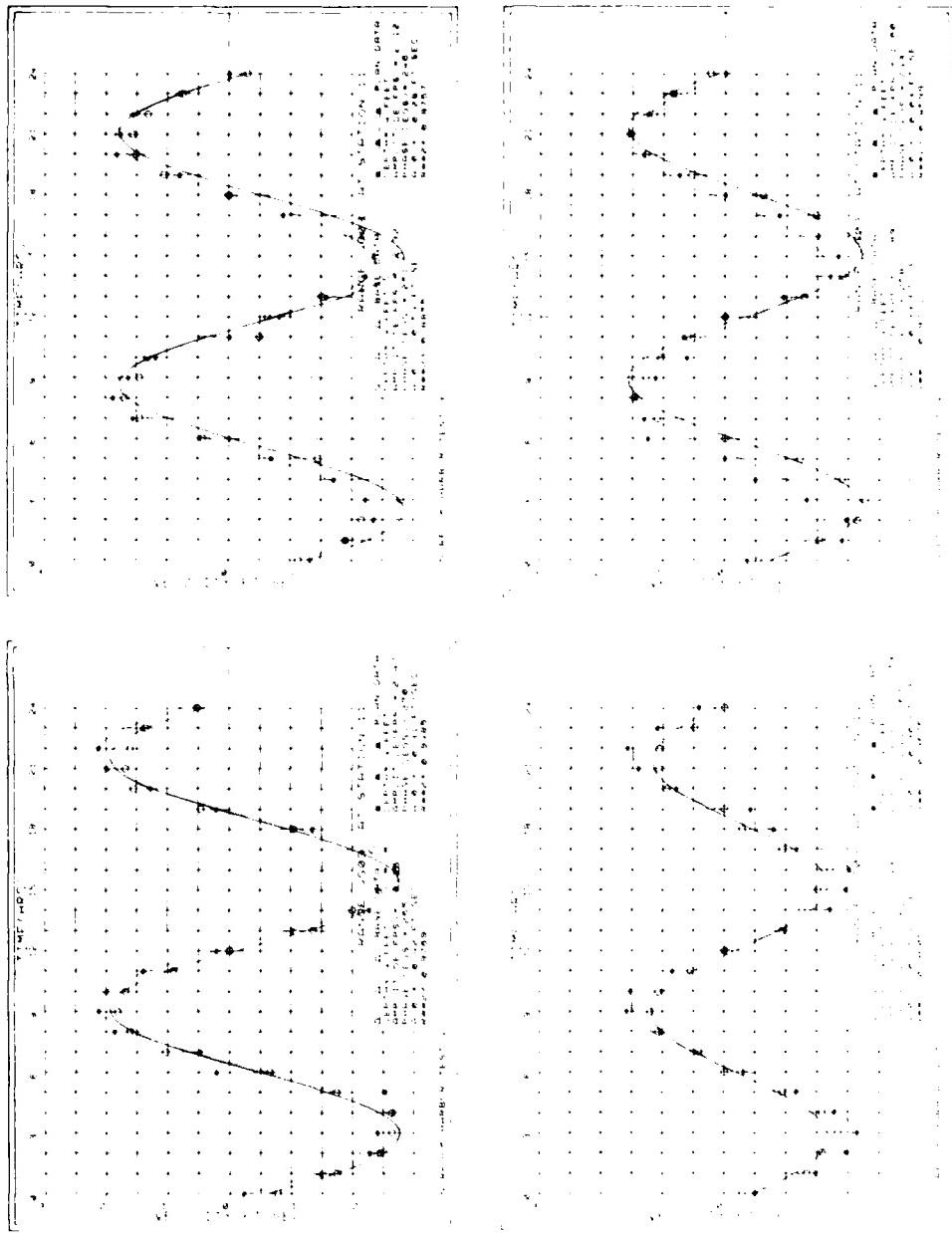


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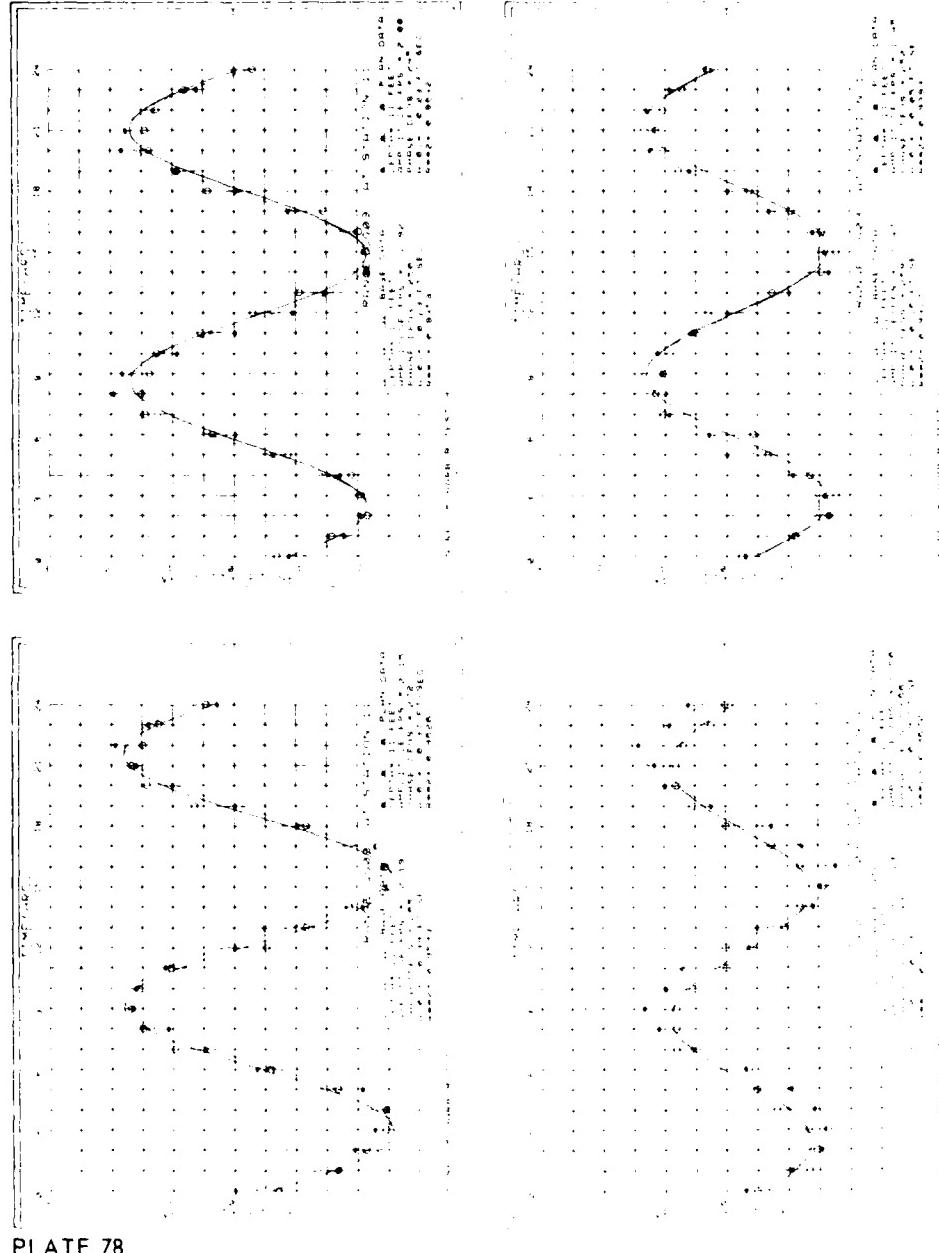


PLATE 78

PLATE 79

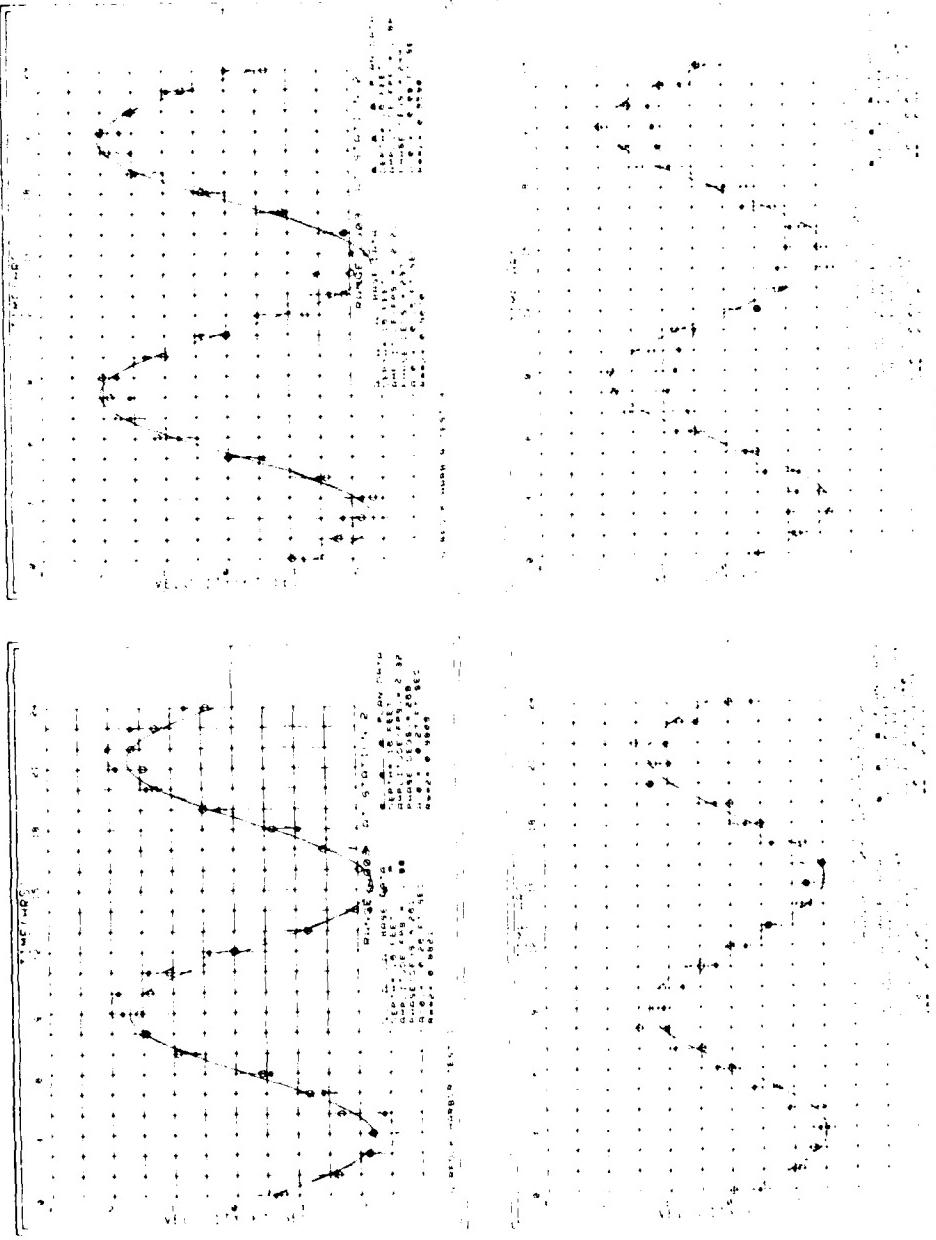


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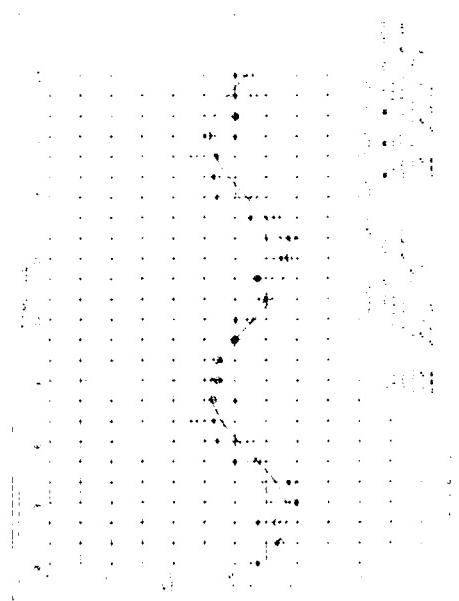
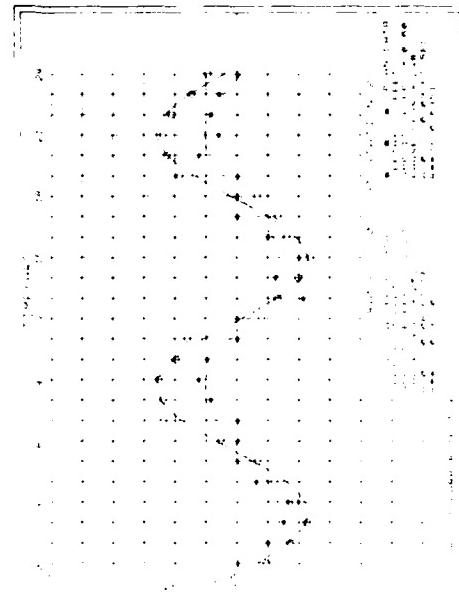
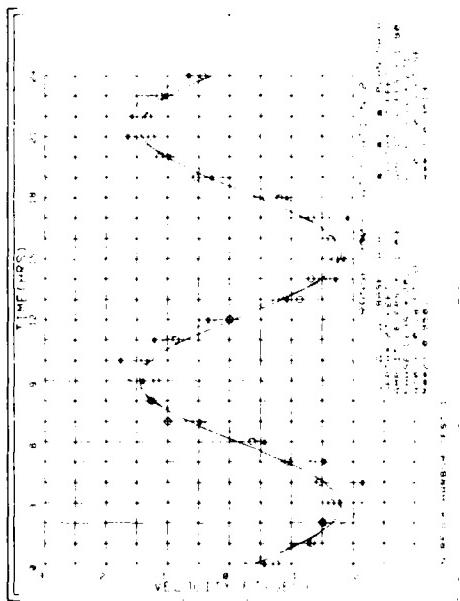
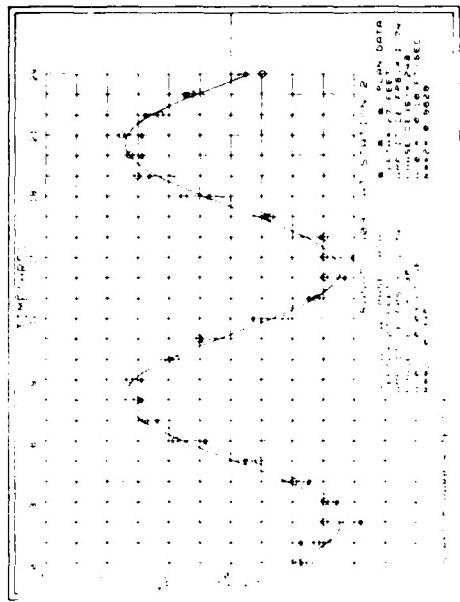


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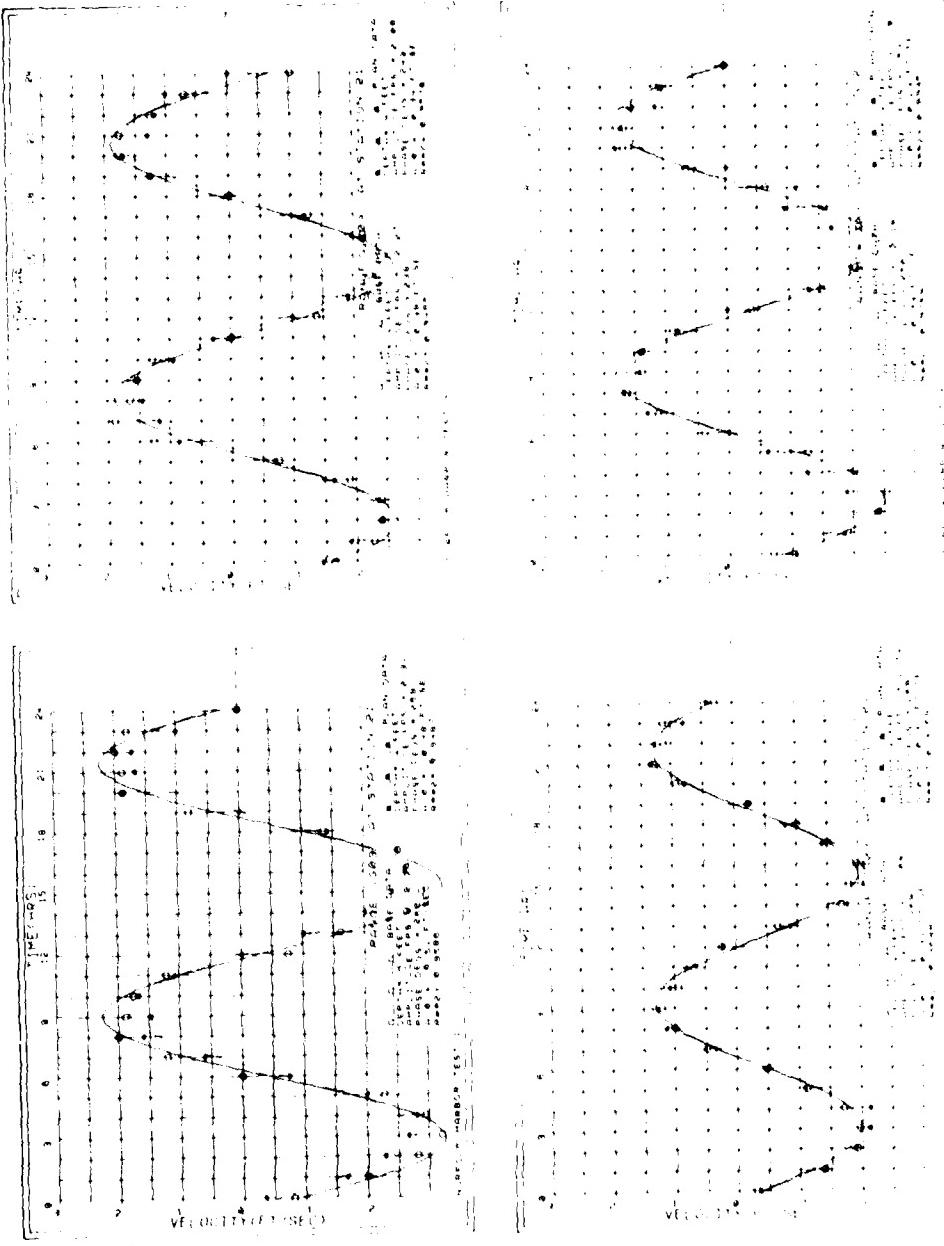


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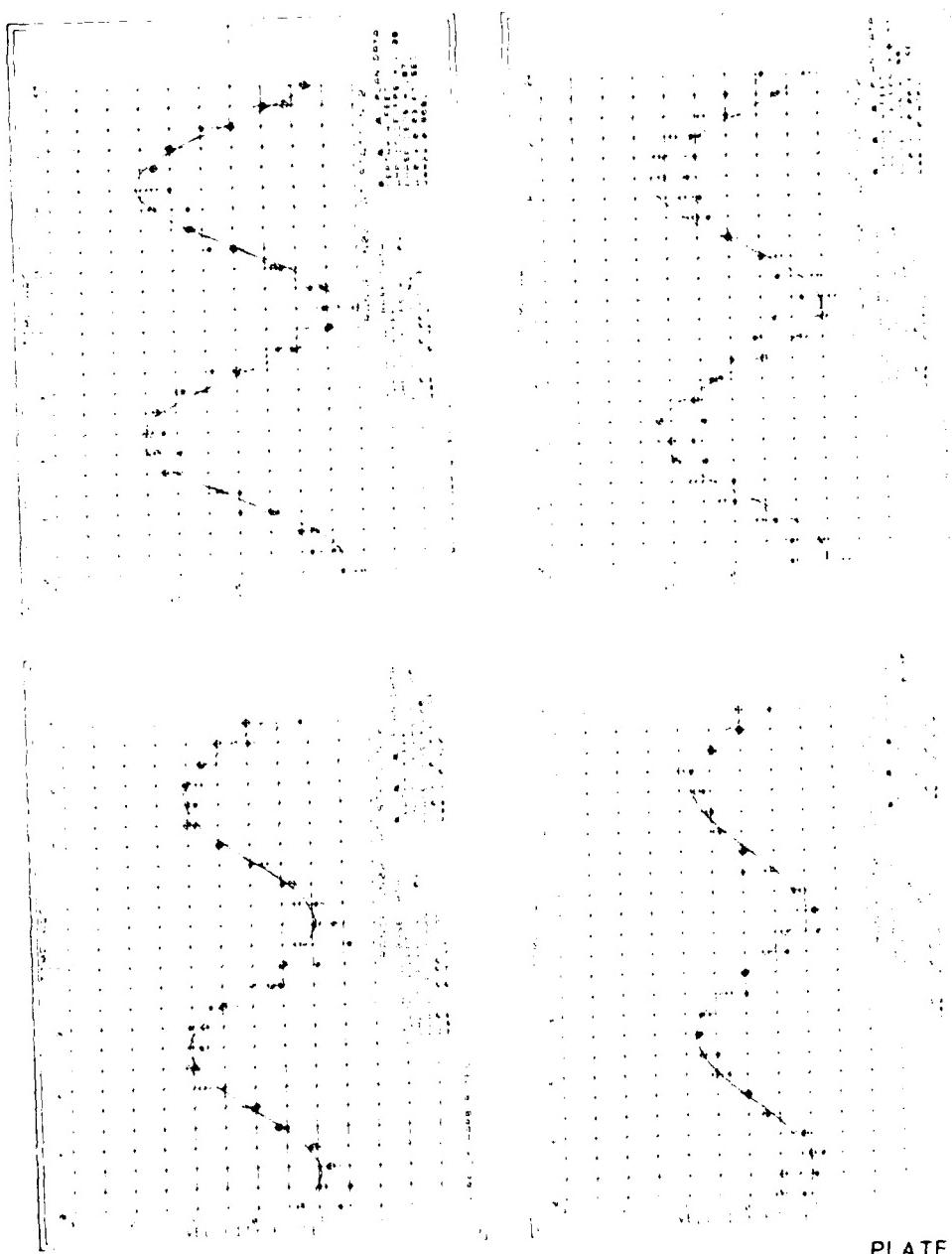


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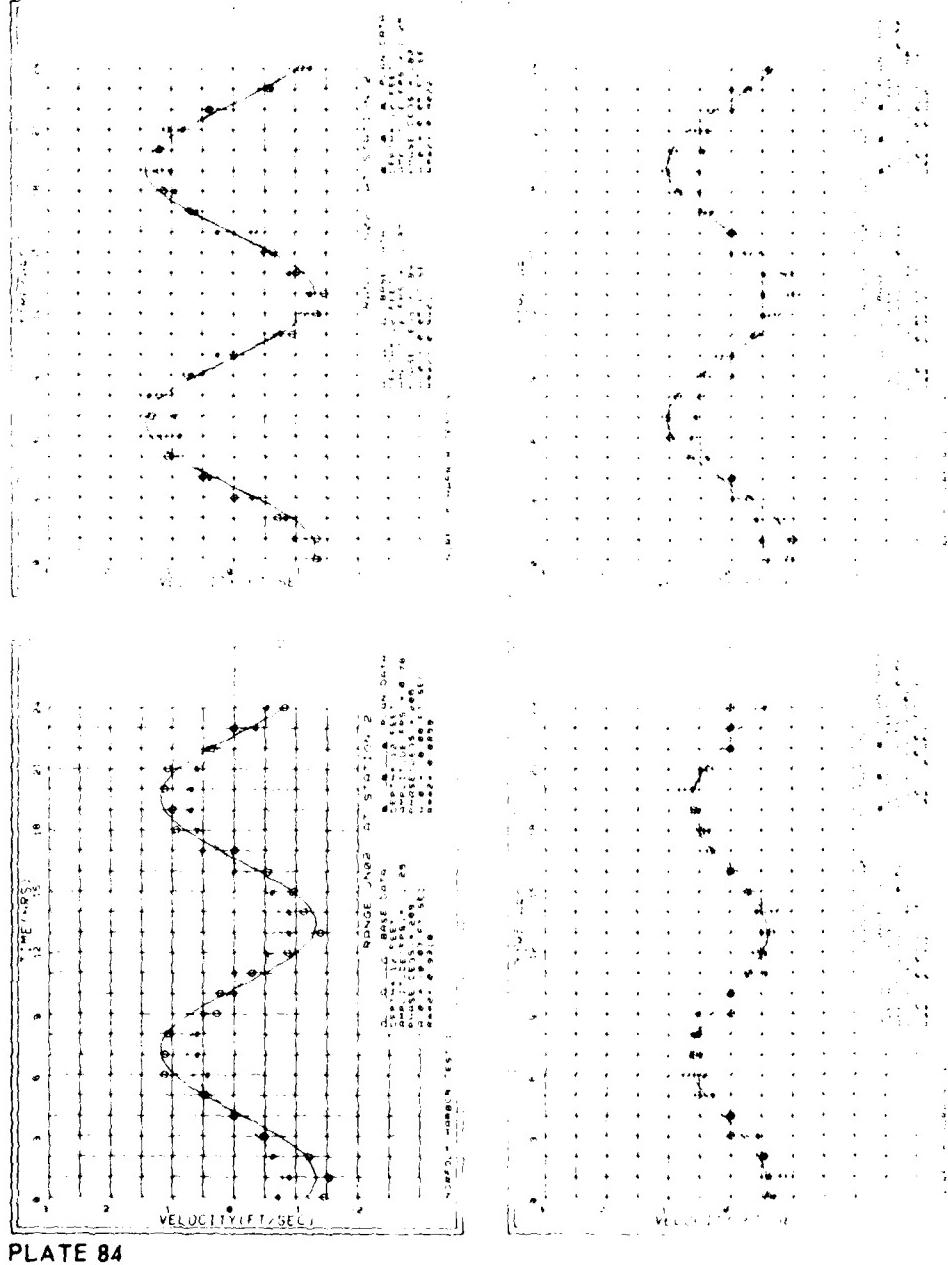


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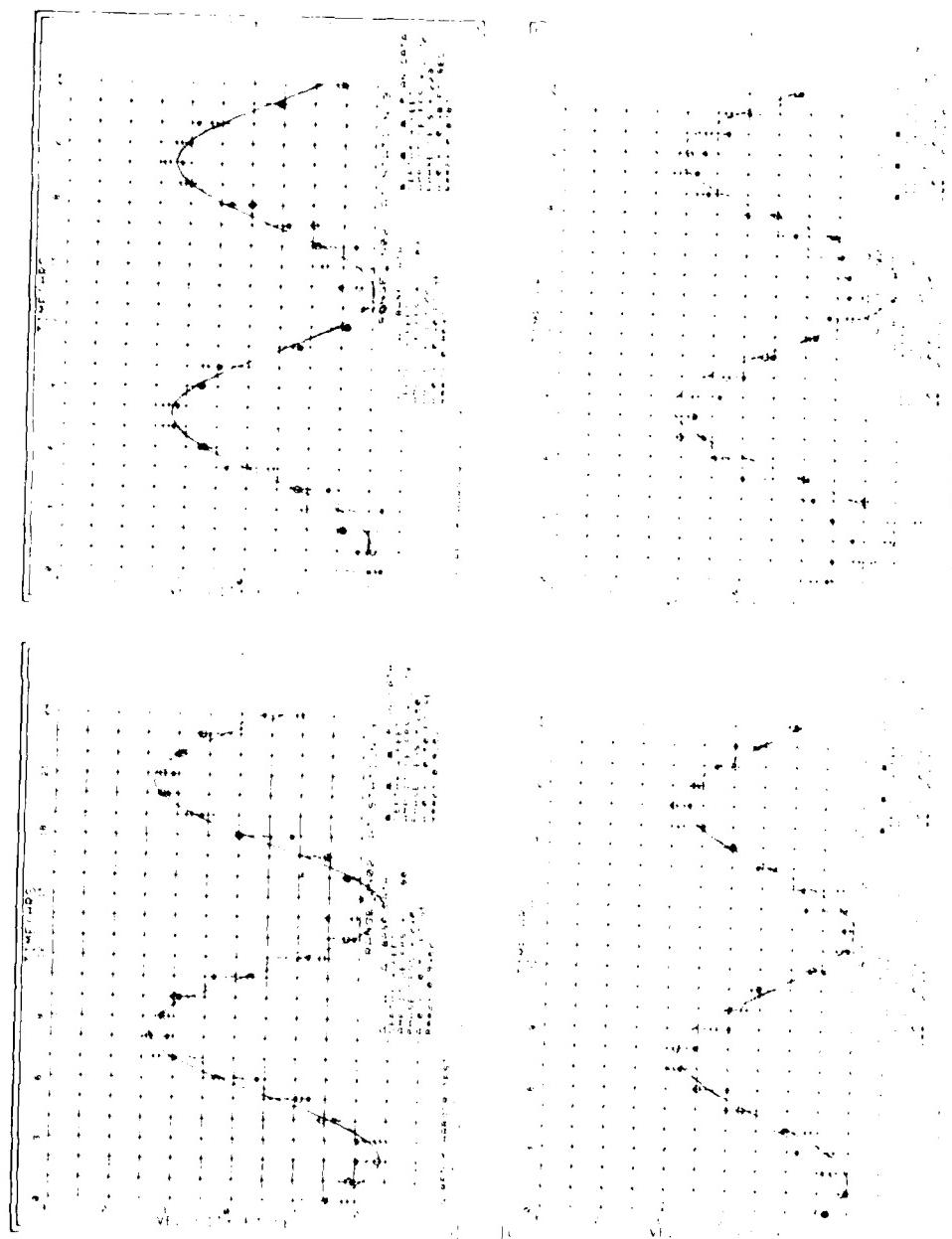


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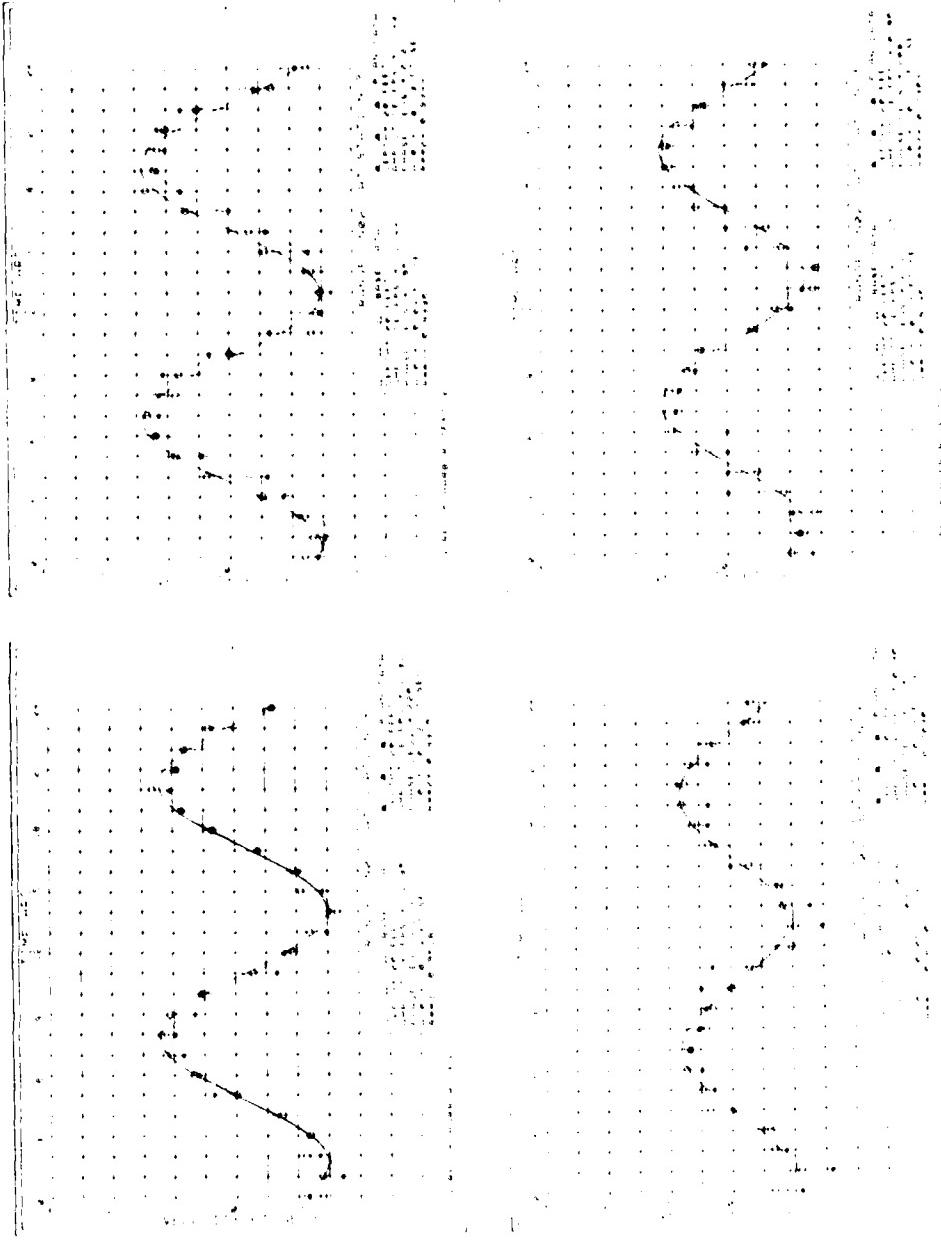


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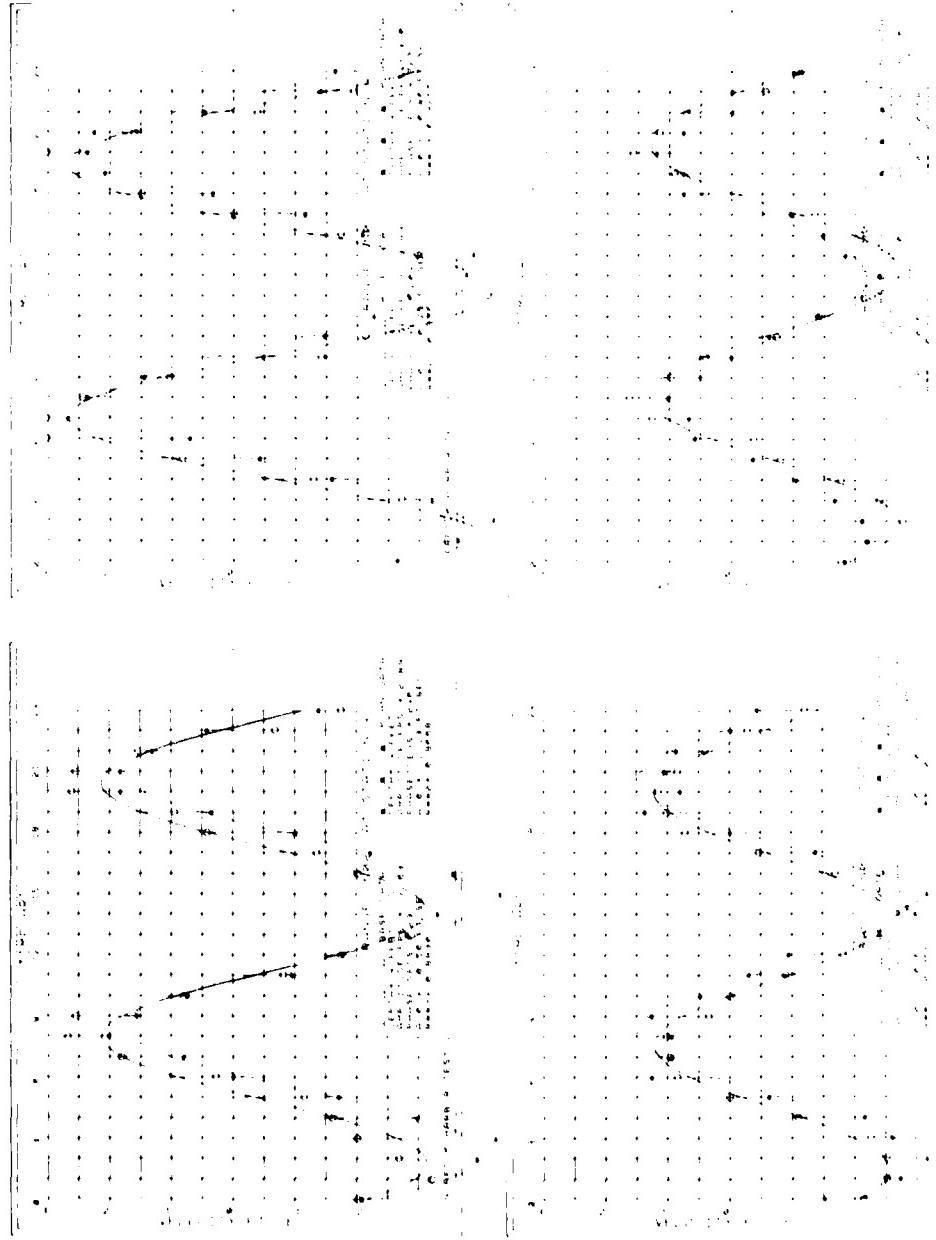


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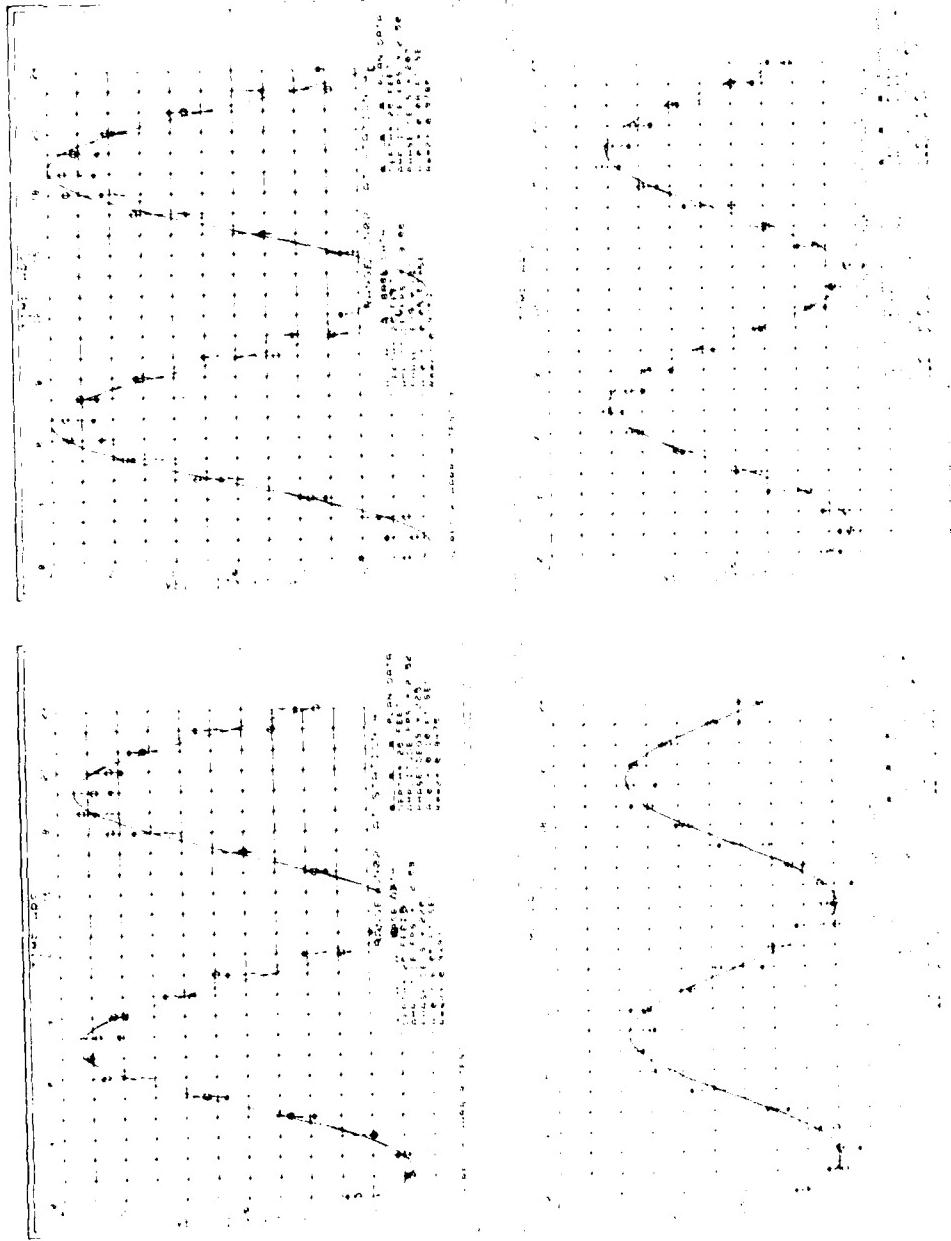


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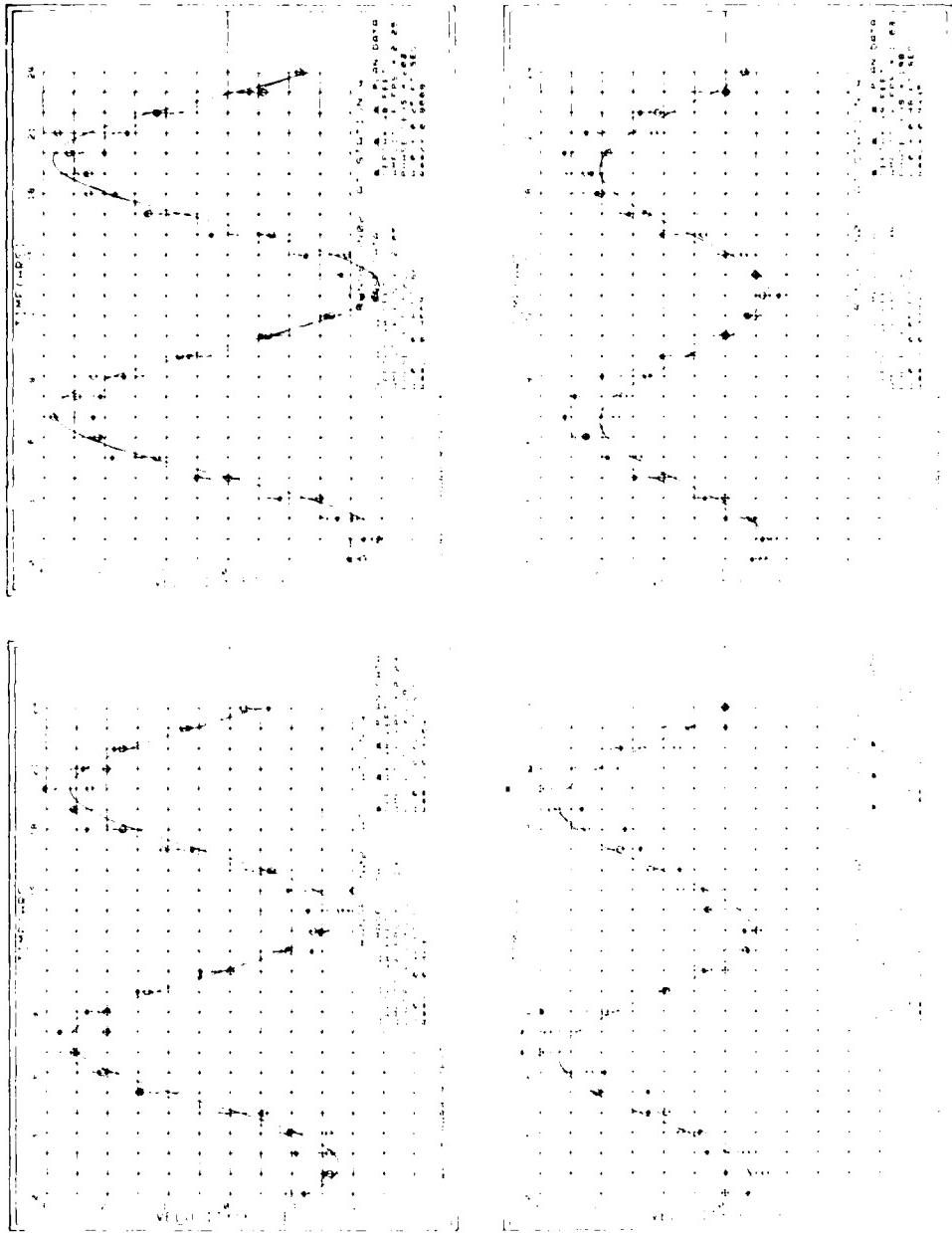


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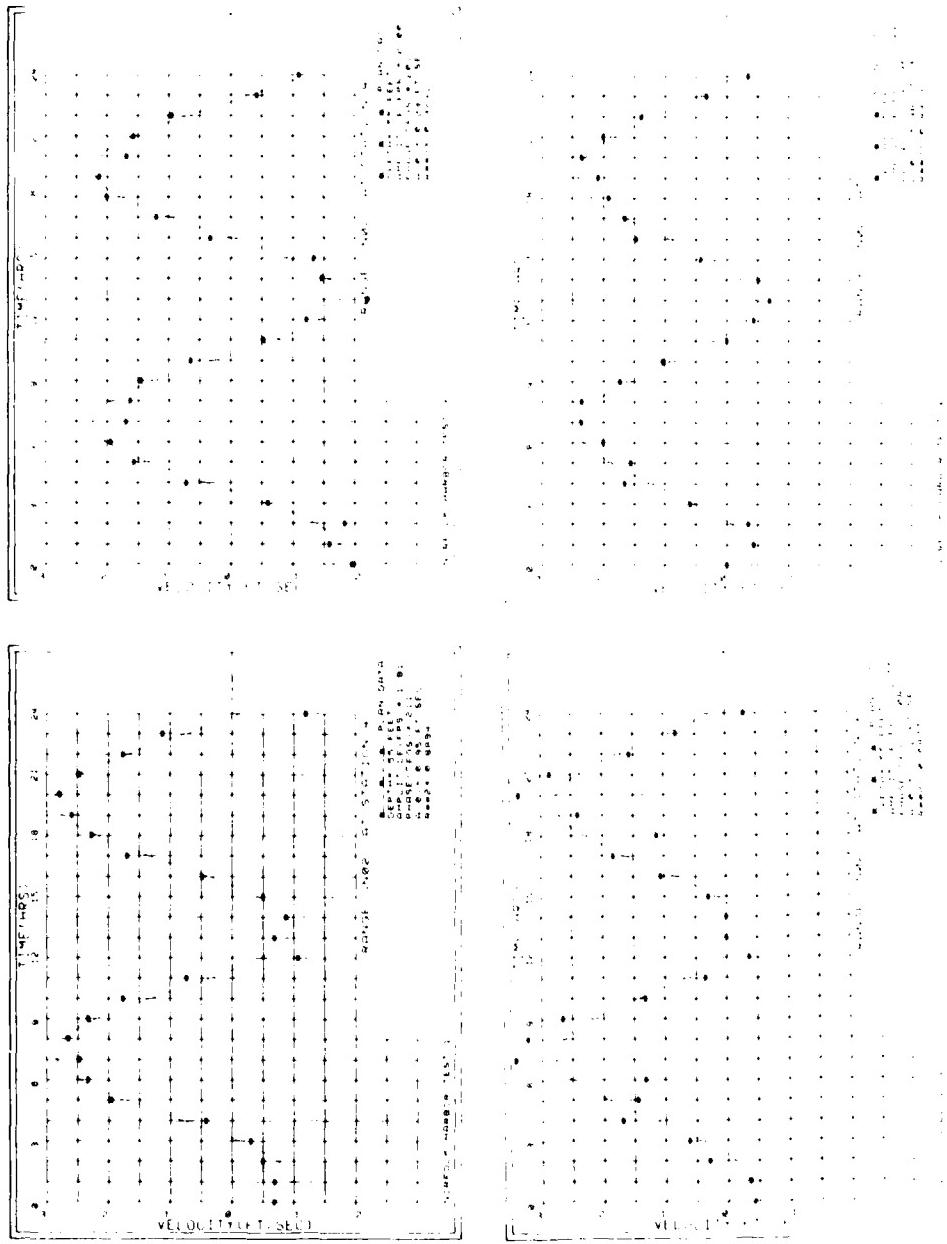


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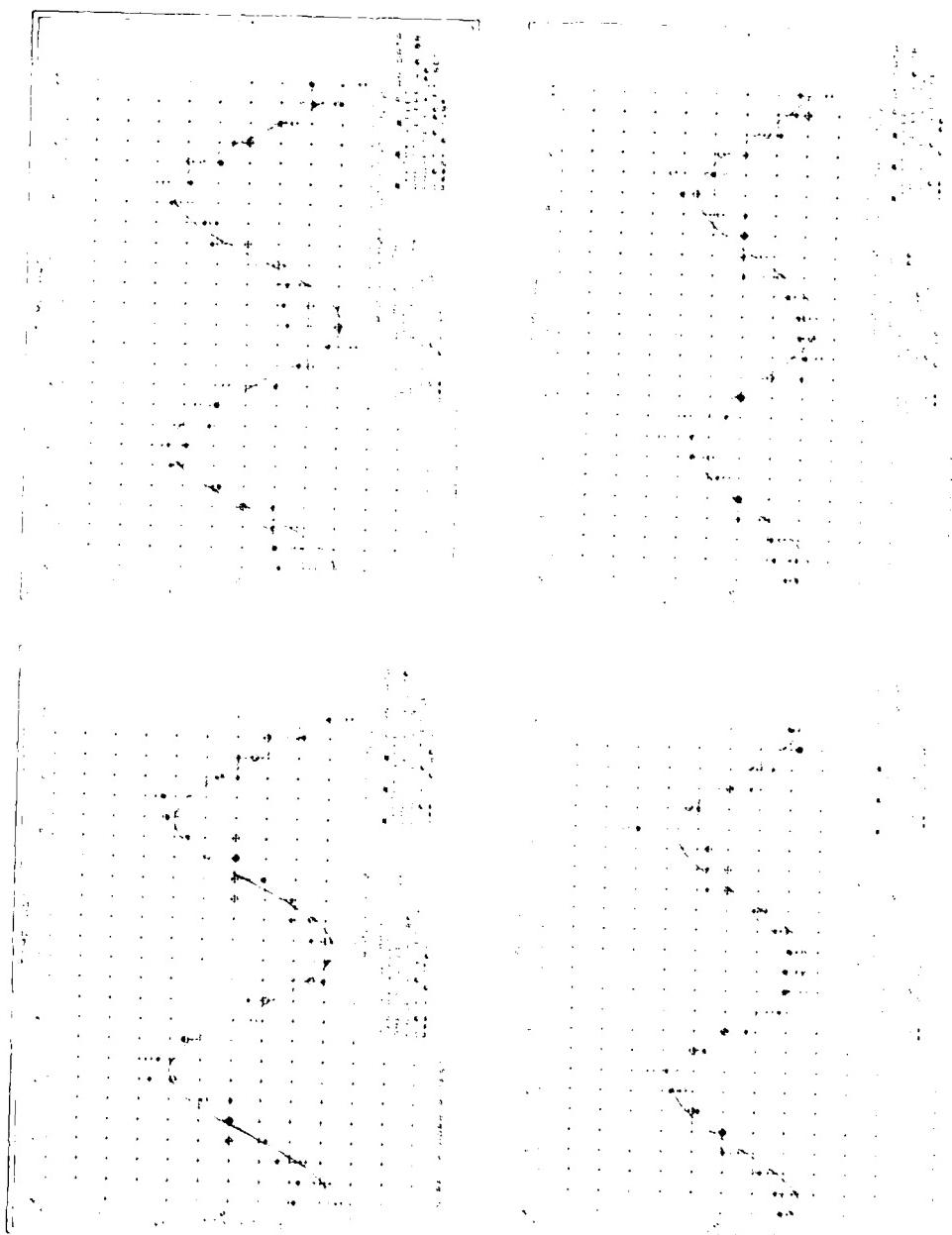


PLATE 91

PLATE 92

PLATE 93

PLATE 94

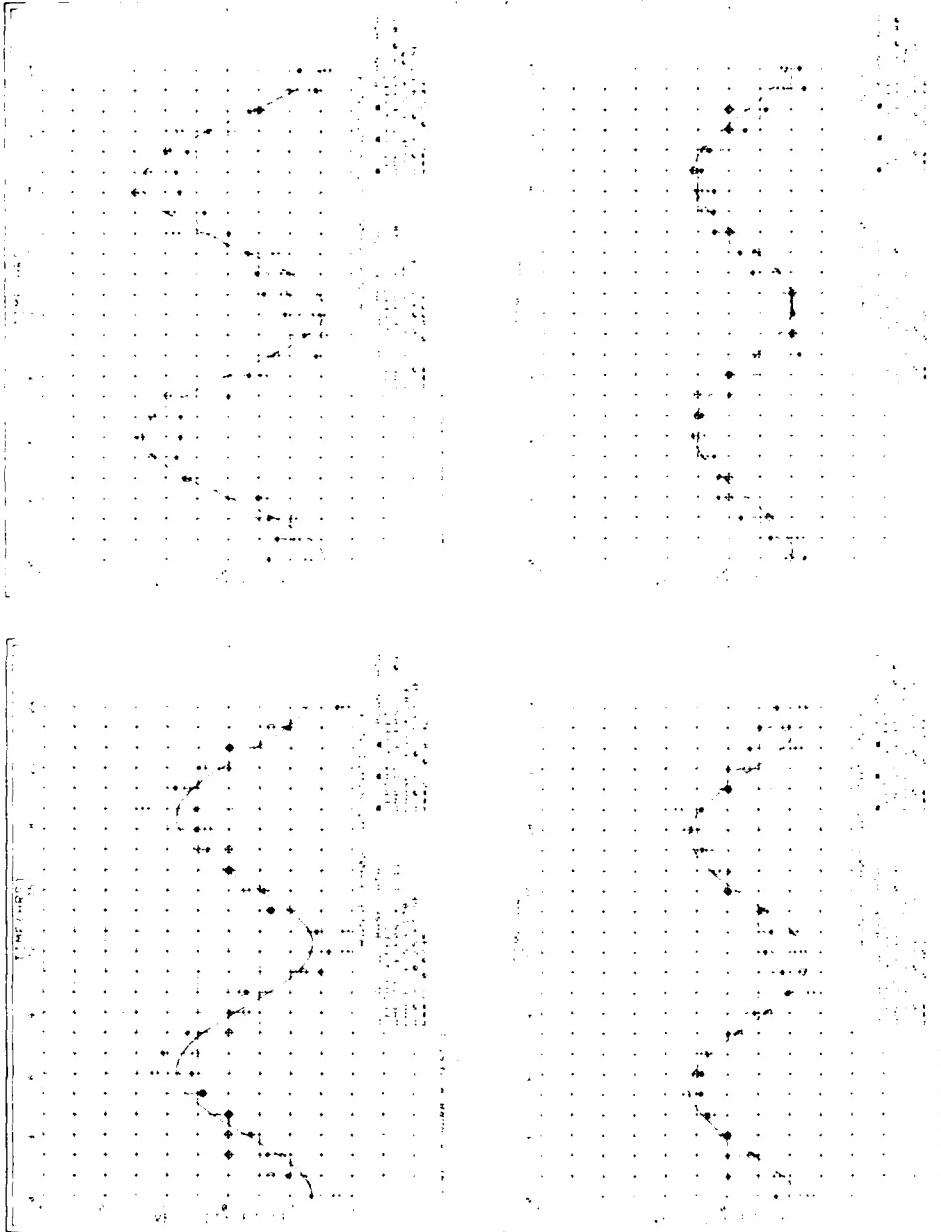


PLATE 95

PLATE 96

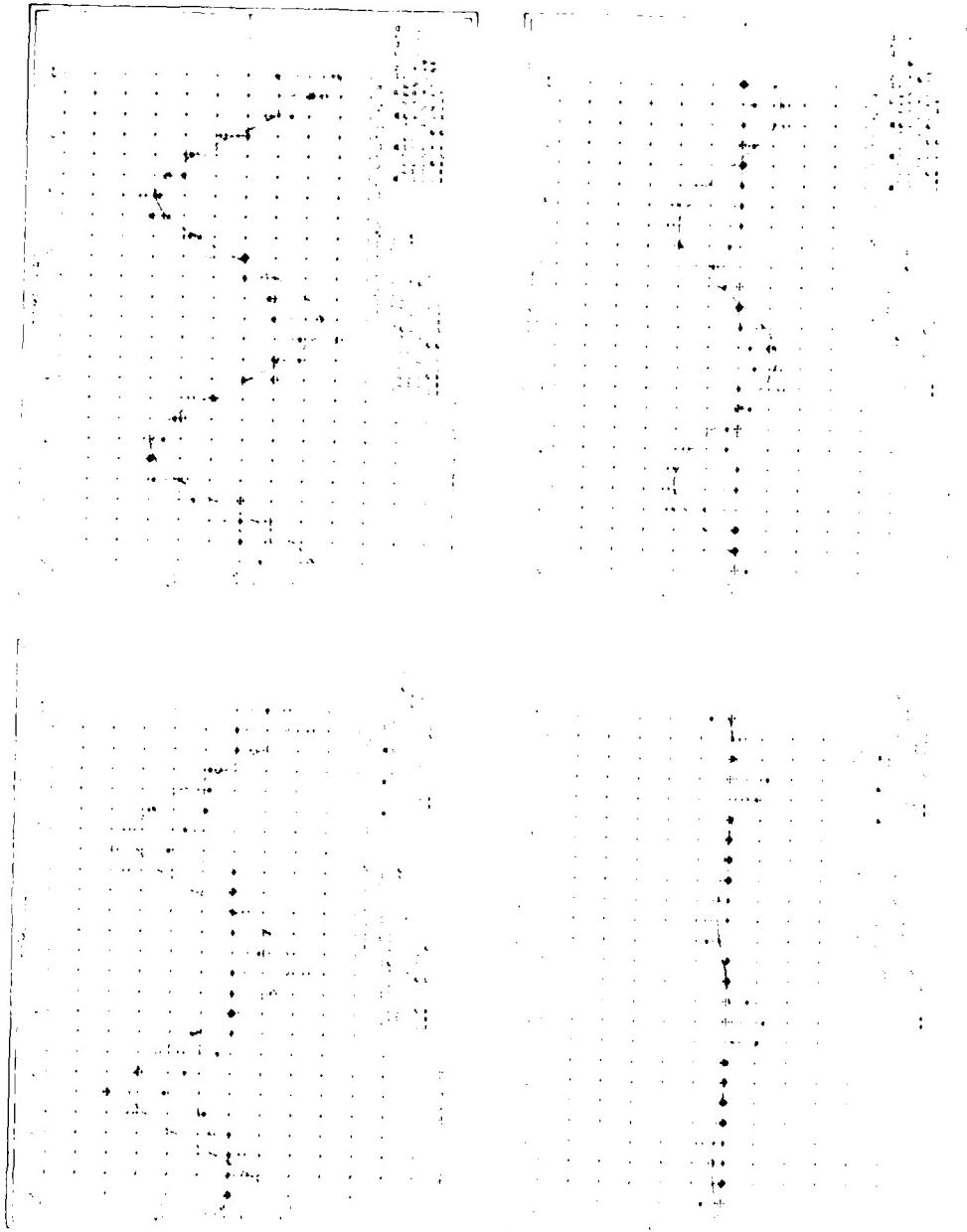


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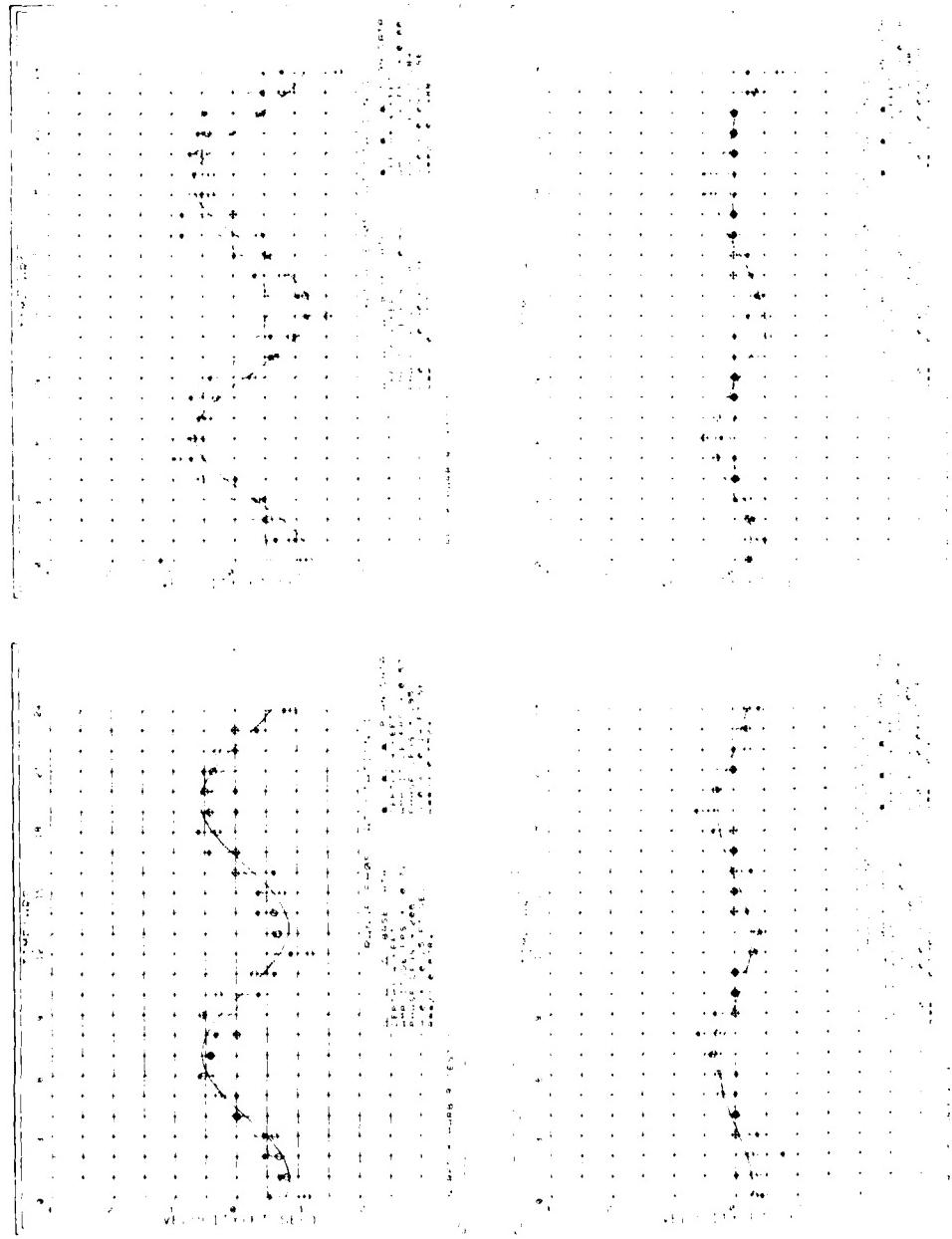


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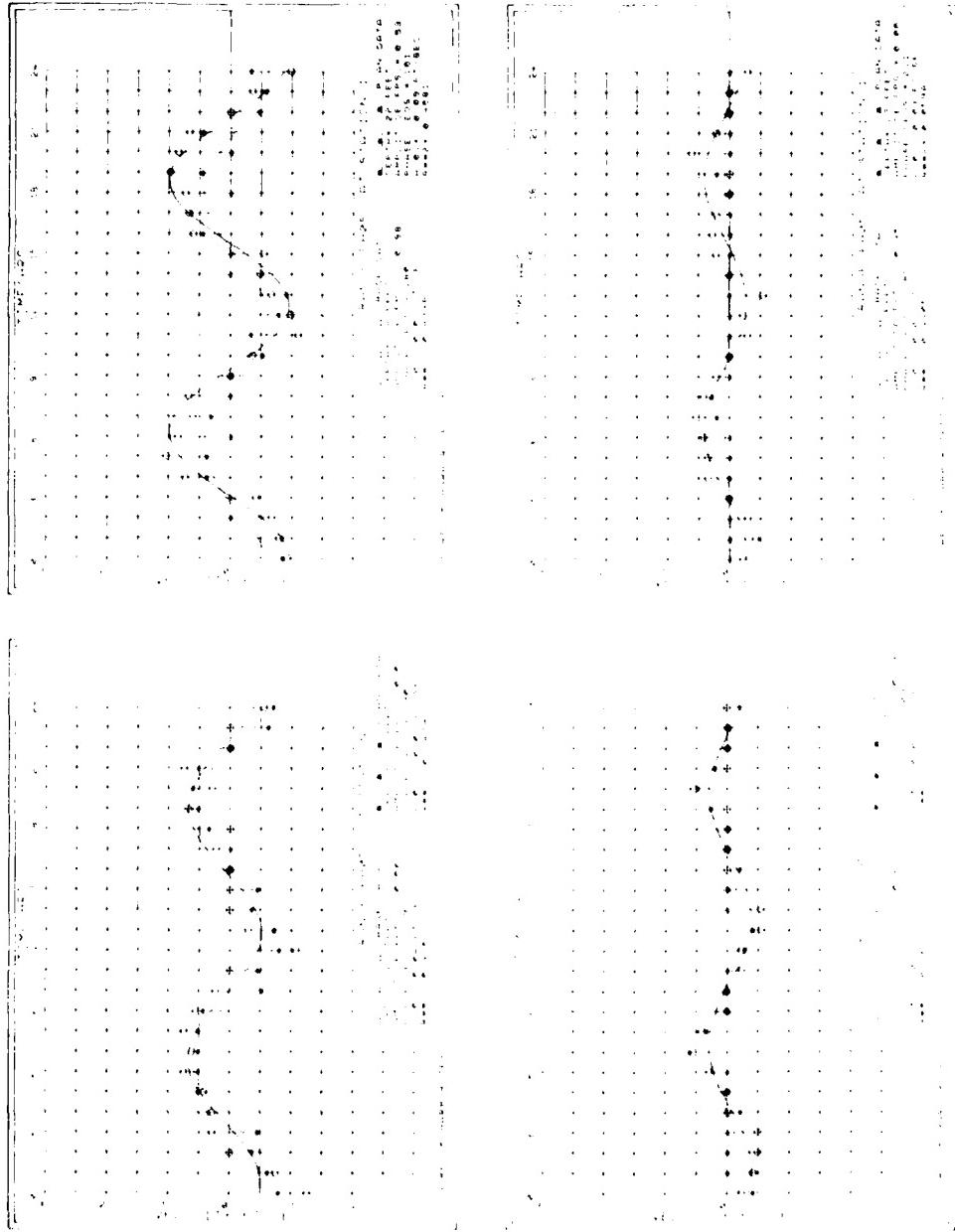


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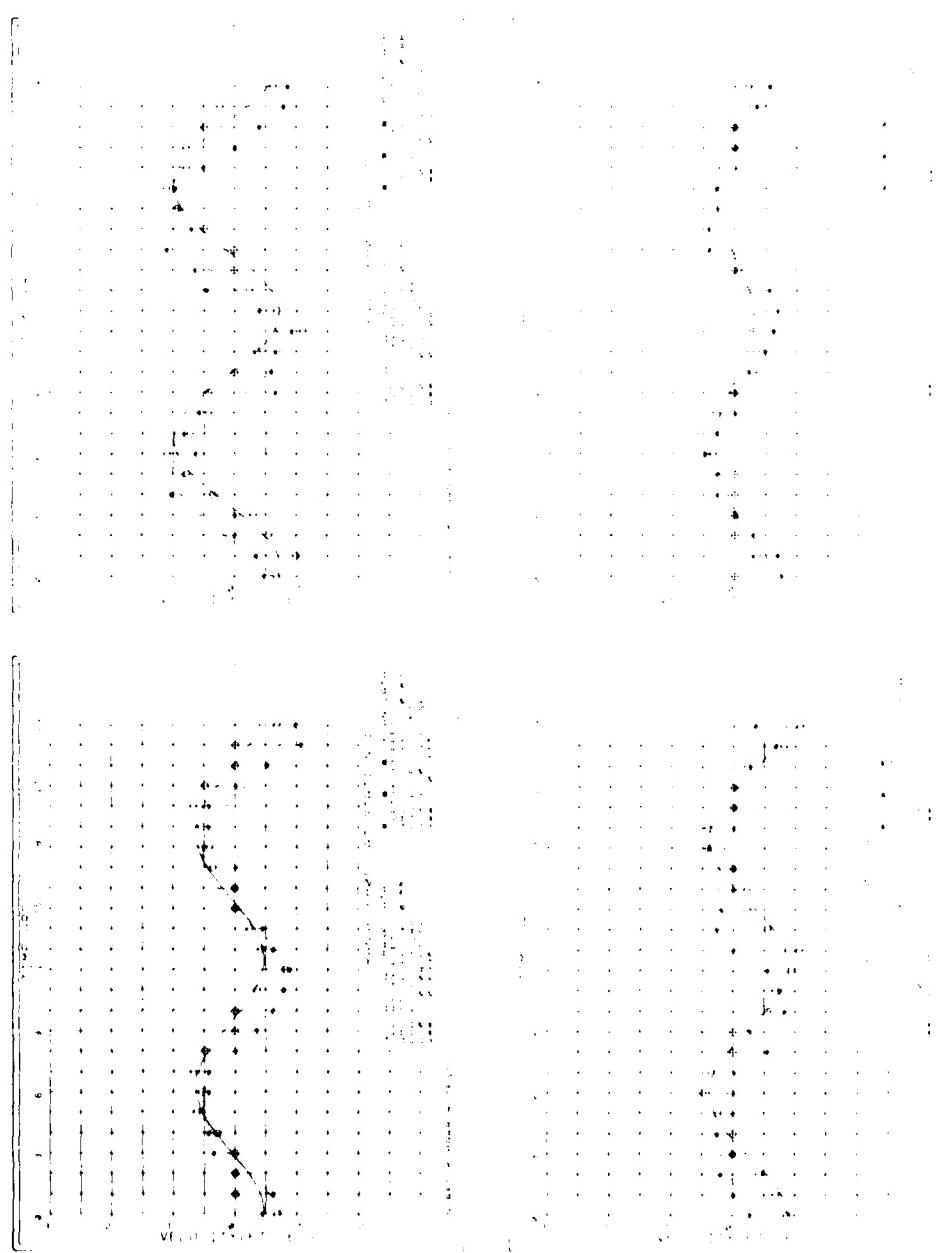


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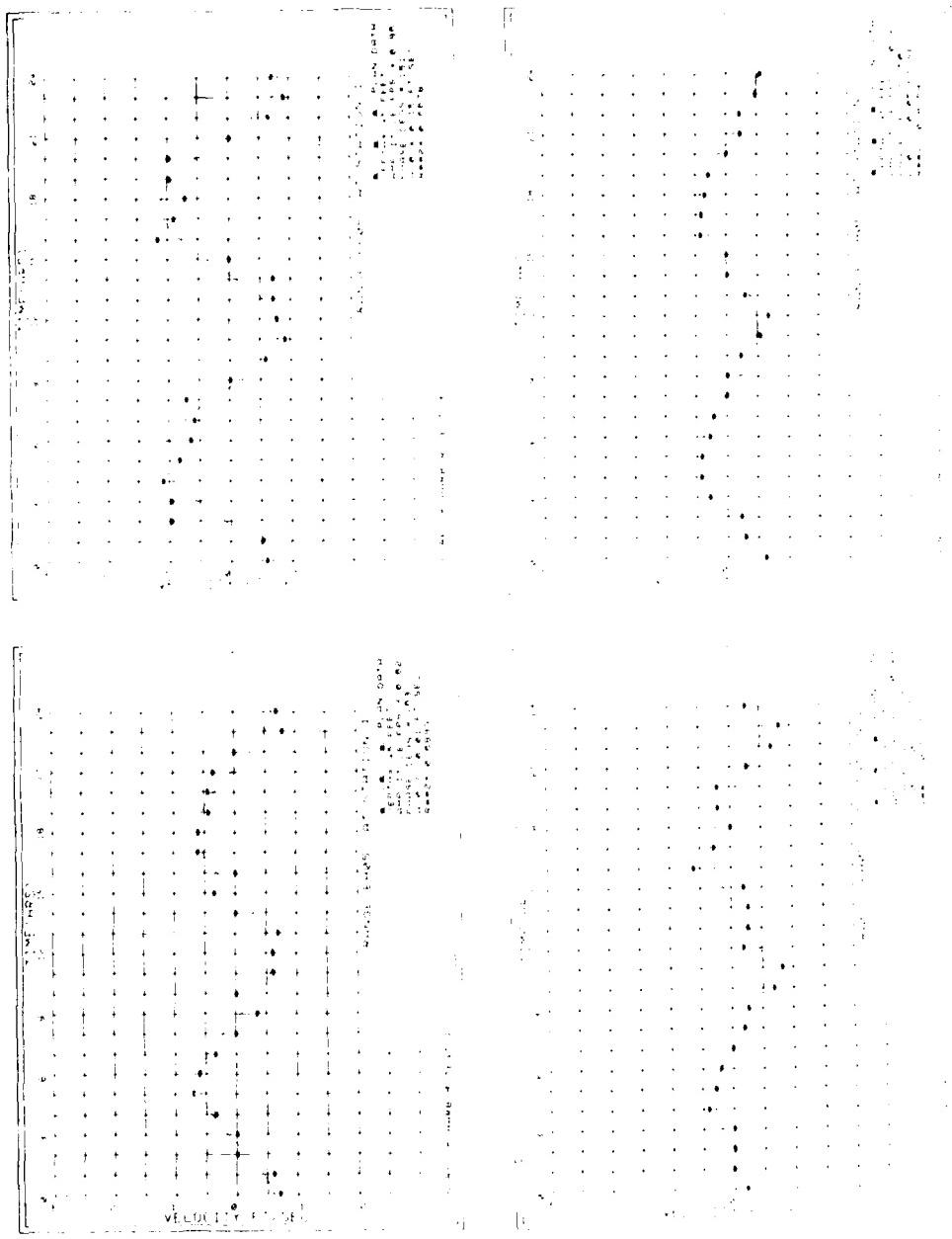


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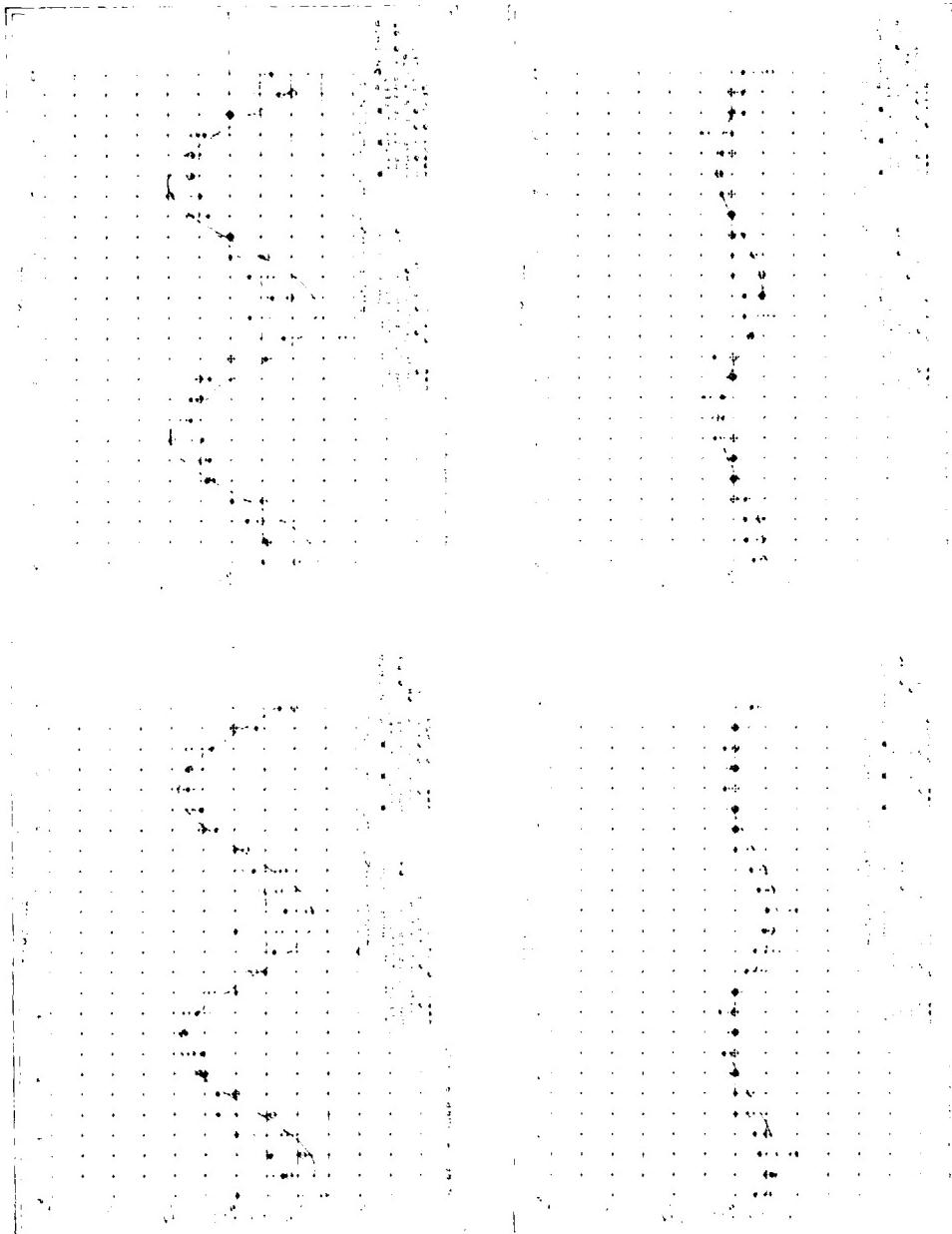


PLATE 102

PLATE 103

PLATE 104

PLATE 105

PLATE 106

PLATE 107

PLATE 108

PLATE 109

PLATE 110

PLATE 111

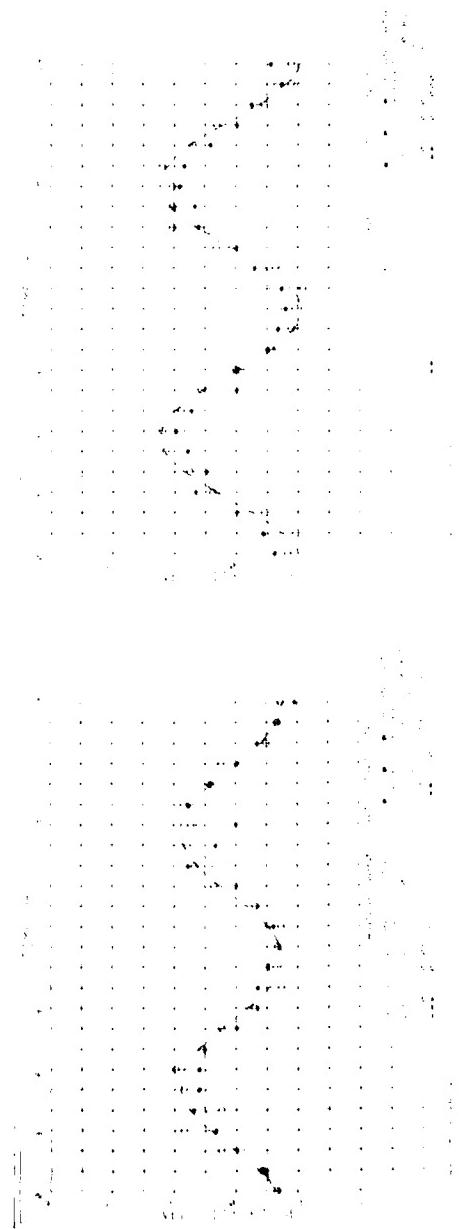
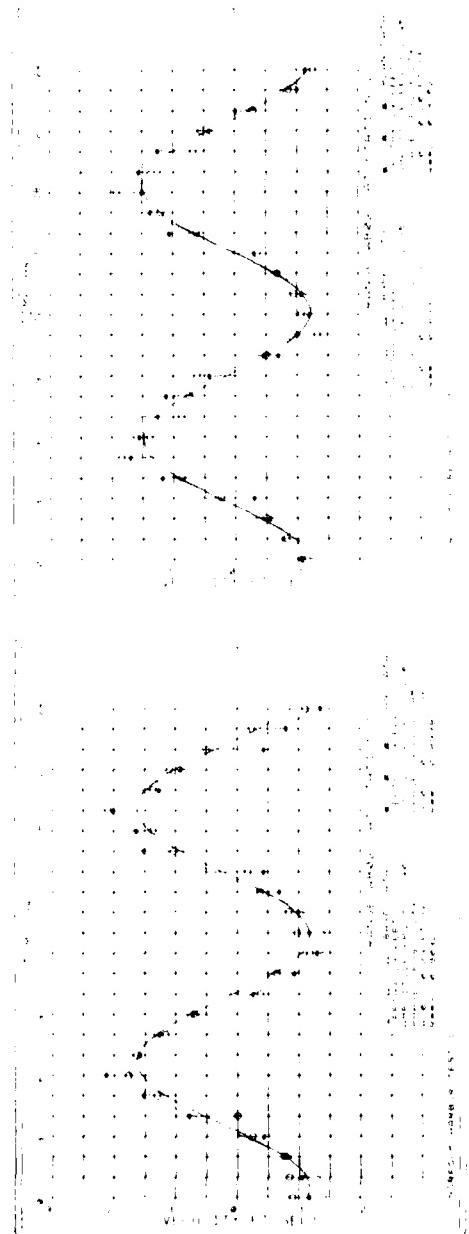


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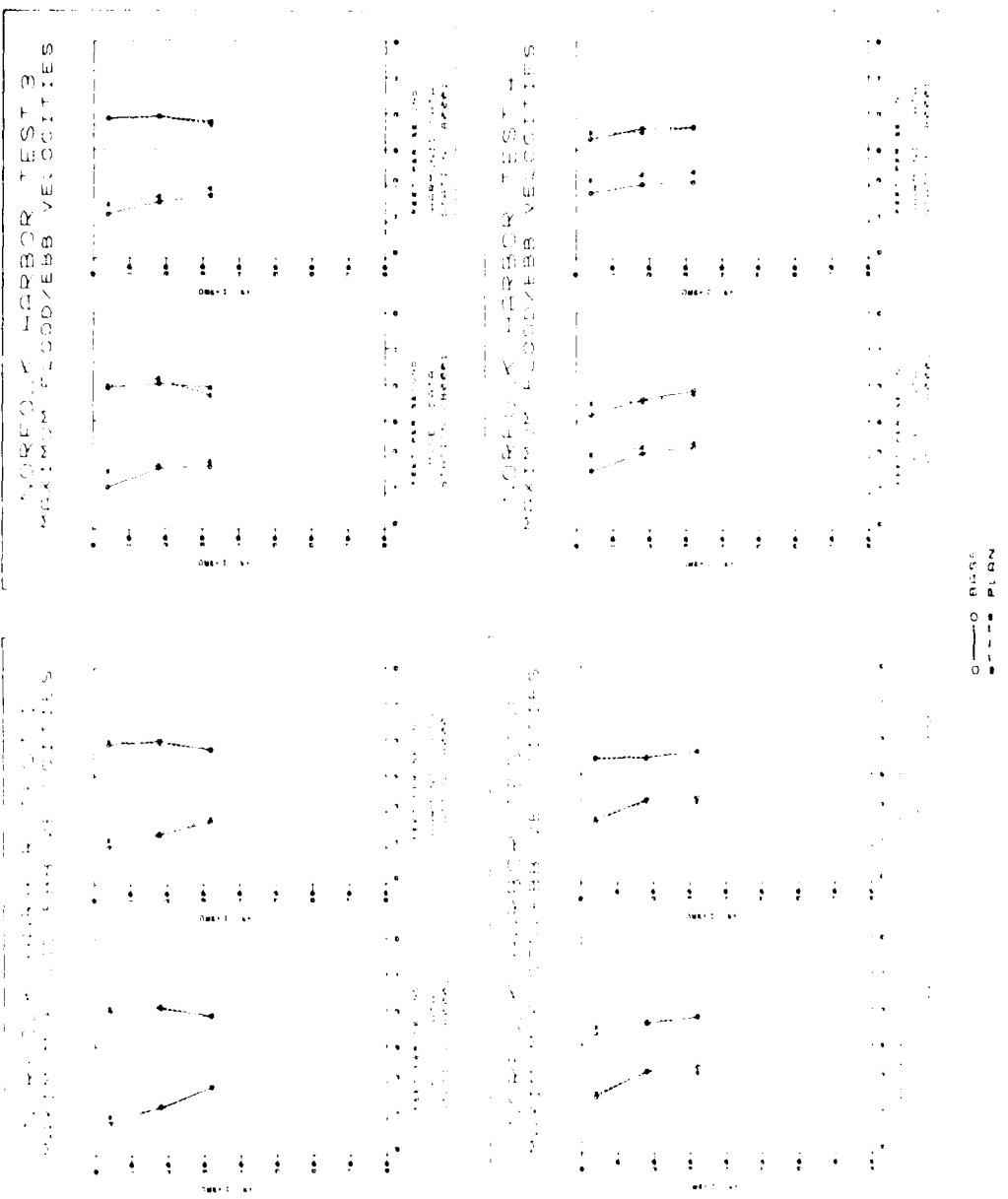


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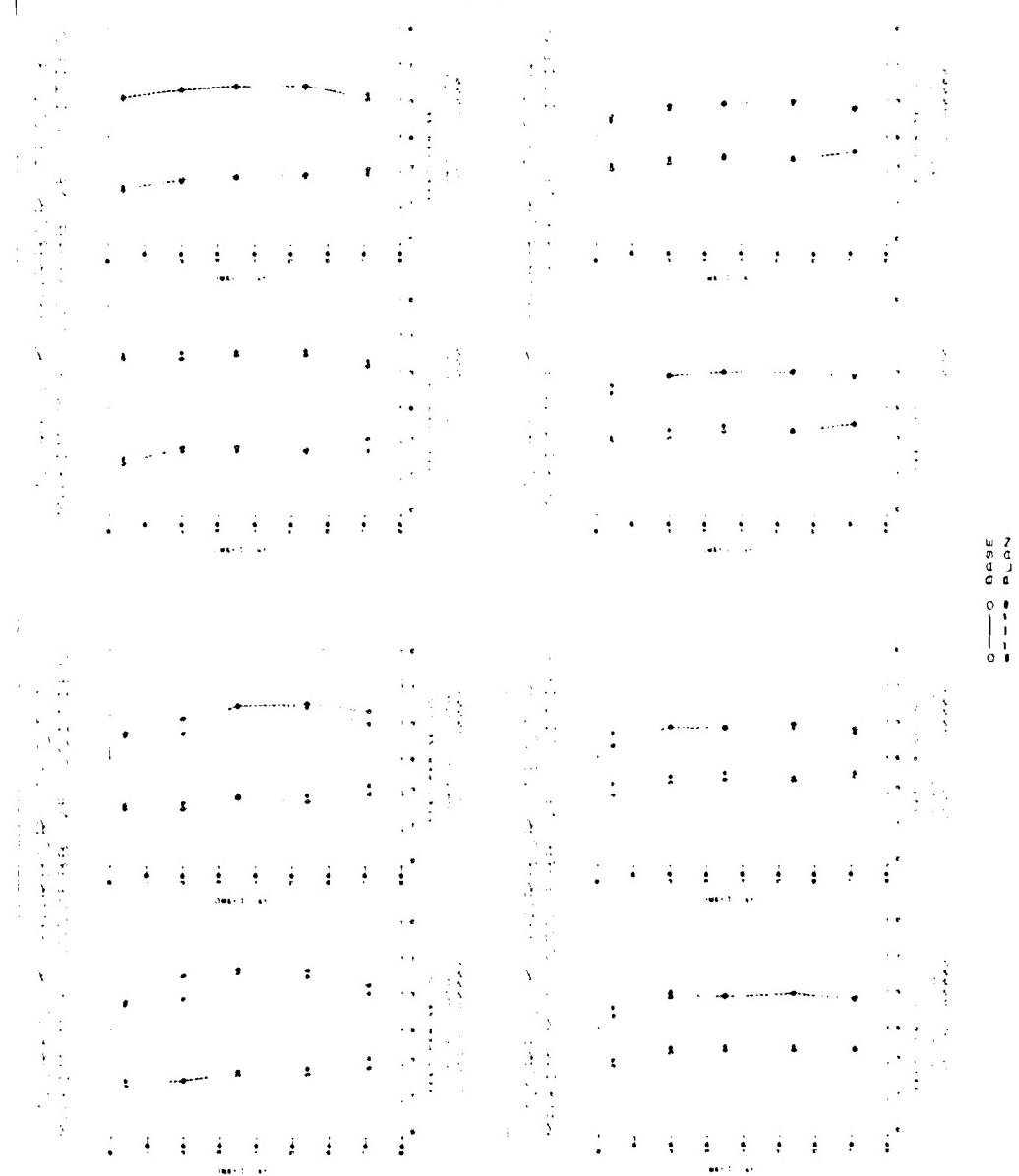


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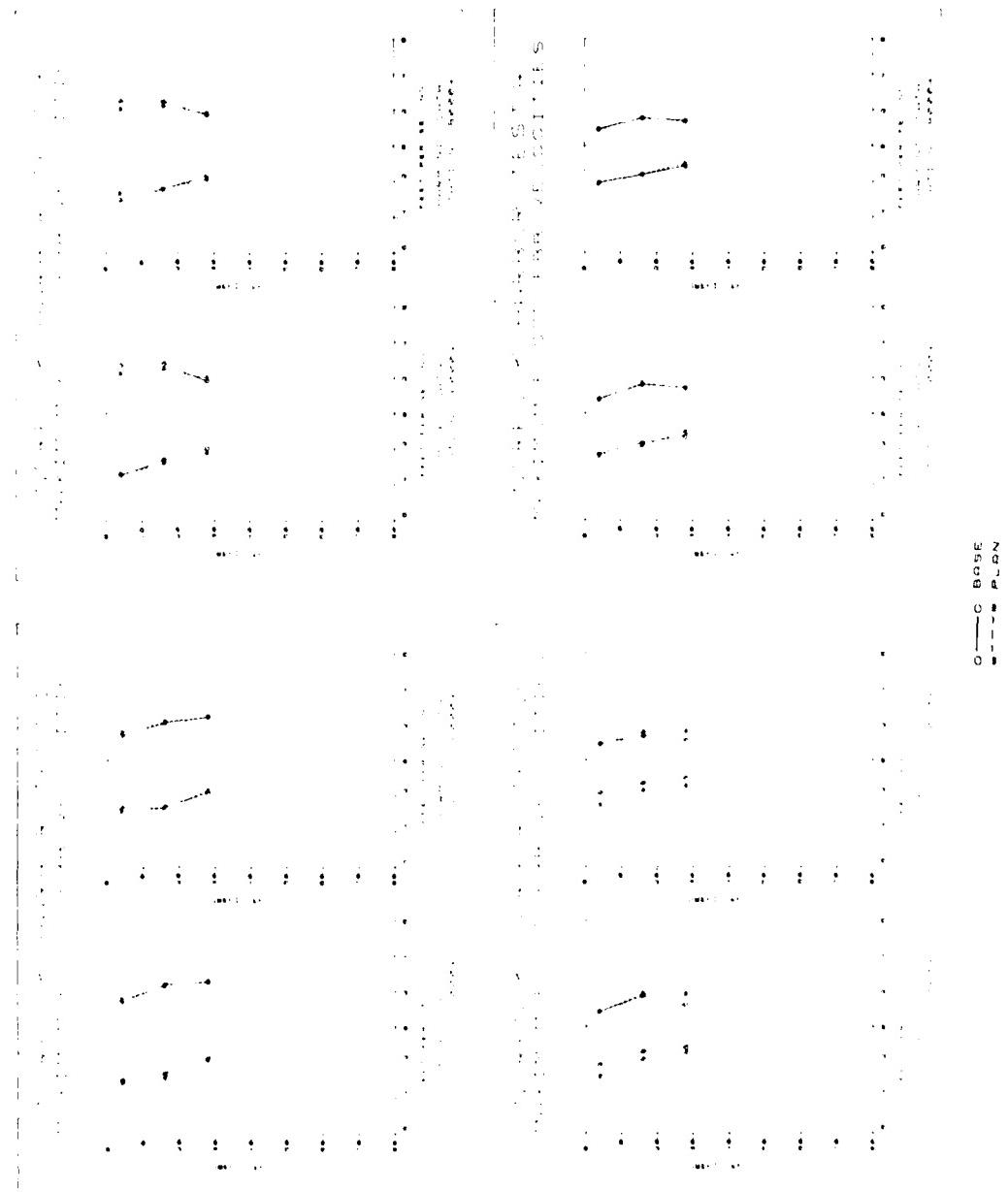
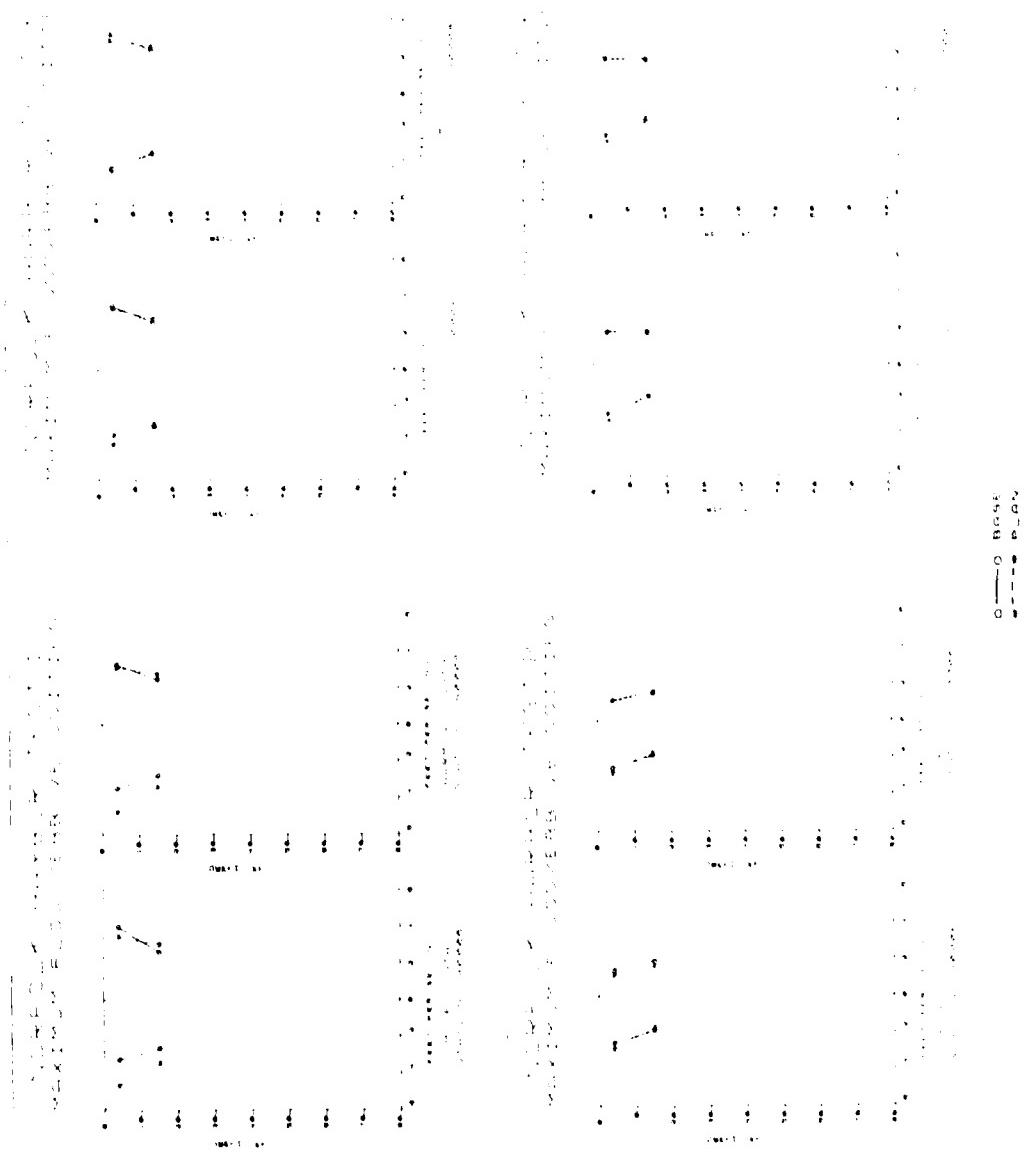
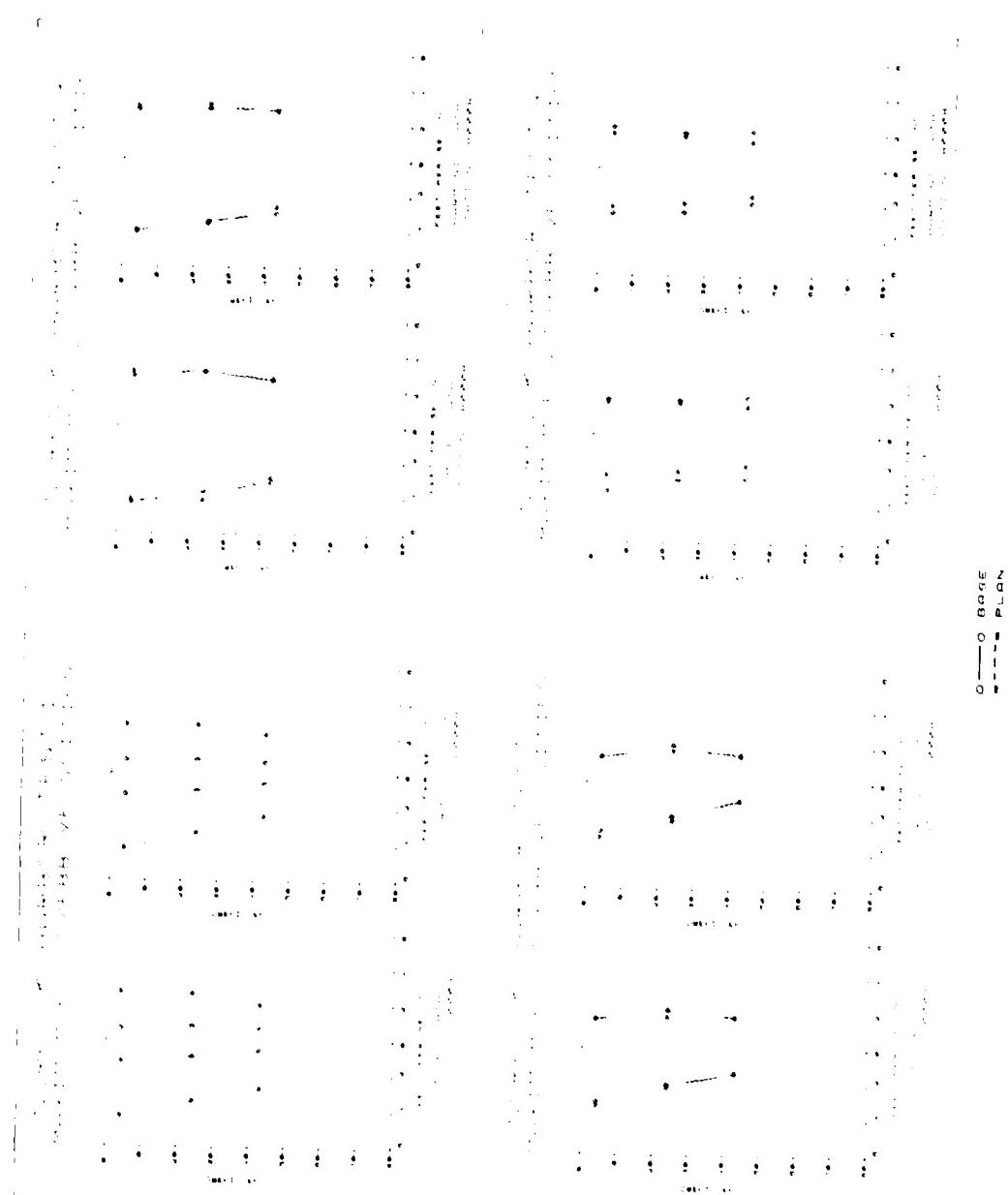


PLATE 115

PLATE 116





— O BASE
— O PLAN

PLATE 117

O --- O BASE
--- ■ PLAN

PLATE 118

— DRAFT
— PLAN

PLATE 119

COASTAL
PLATE

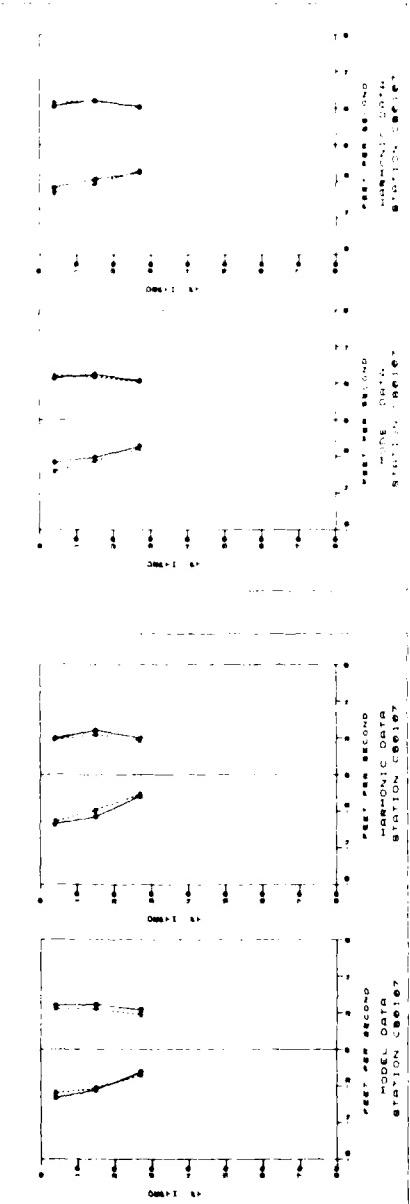
PLATE 120

0 1000 2000
0 1000 2000

PLATE 121

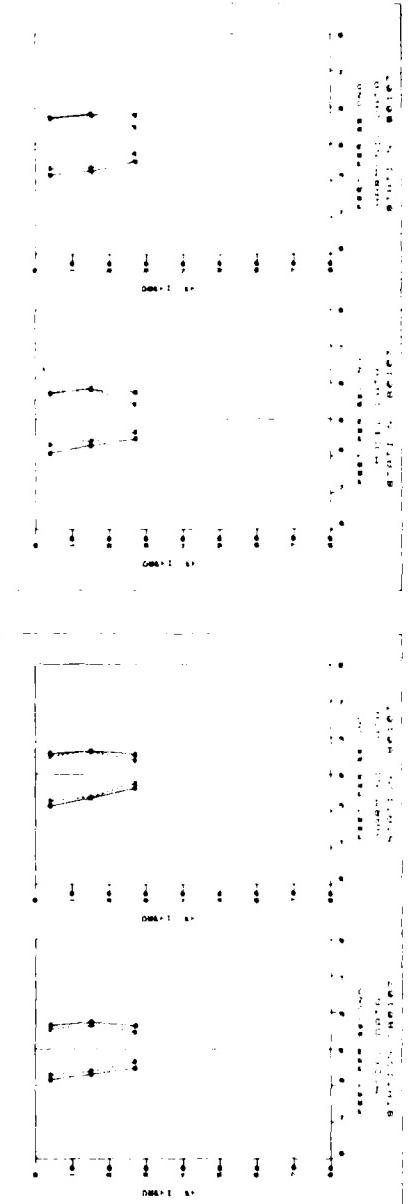
NORFOLK HARBOR TEST 3

MAXIMUM FLOOD/EBB VELOCITIES



NORFOLK HARBOR TEST 4

MAXIMUM FLOOD/EBB VELOCITIES



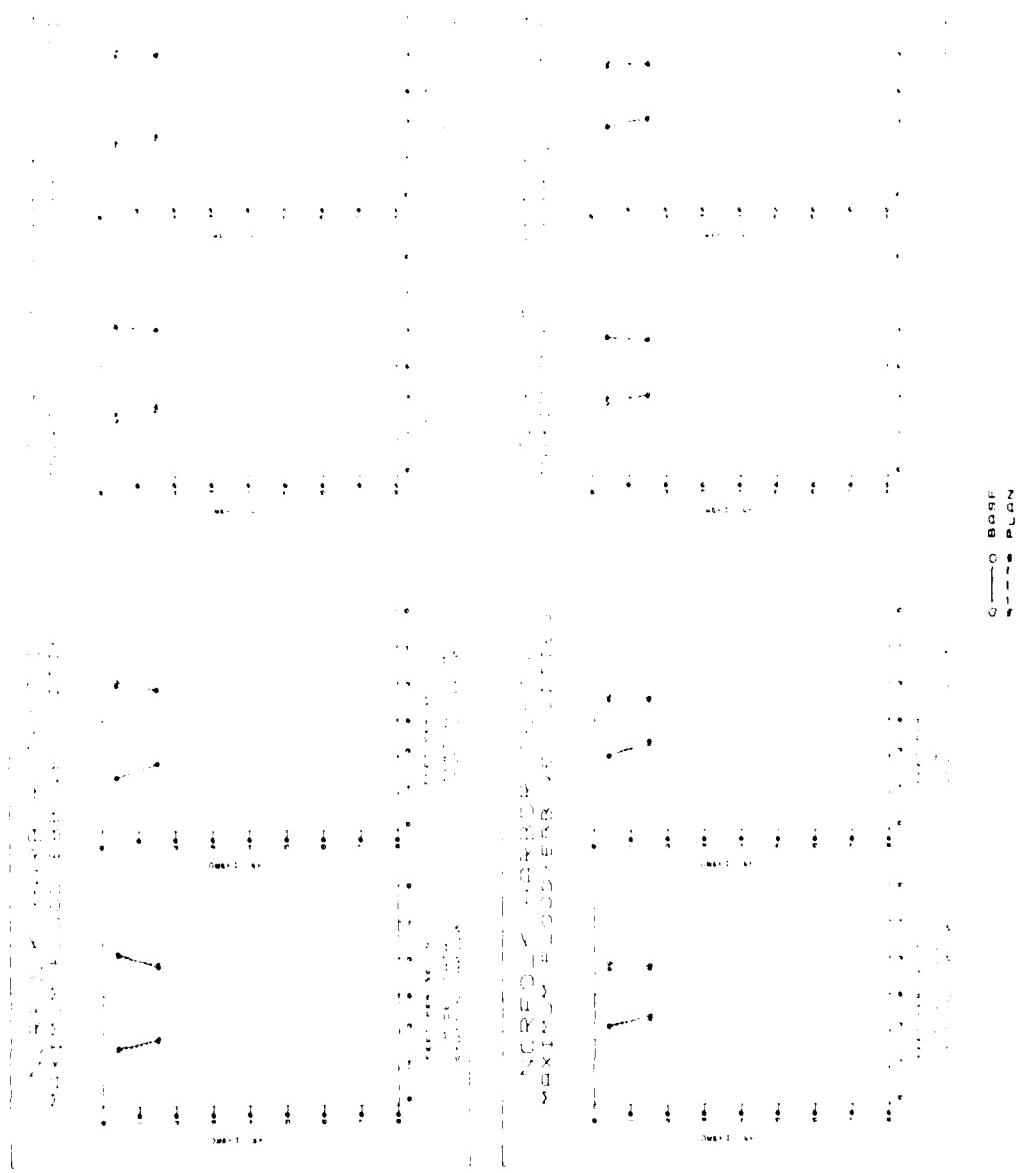
—○— BASE
—●— PLAN

PLATE 122

PLATE 123

PLATE 123

PLATE 124



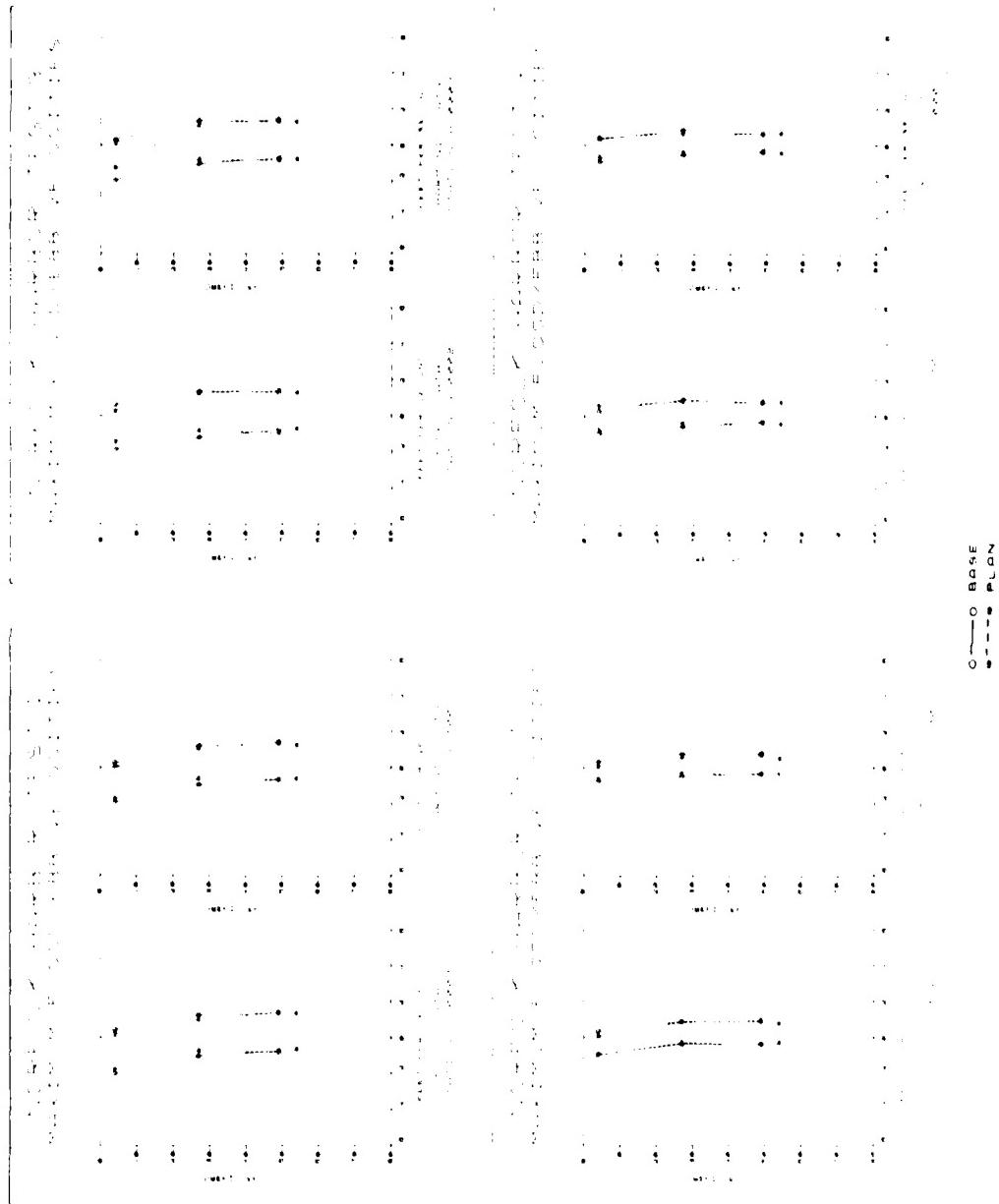


PLATE 125

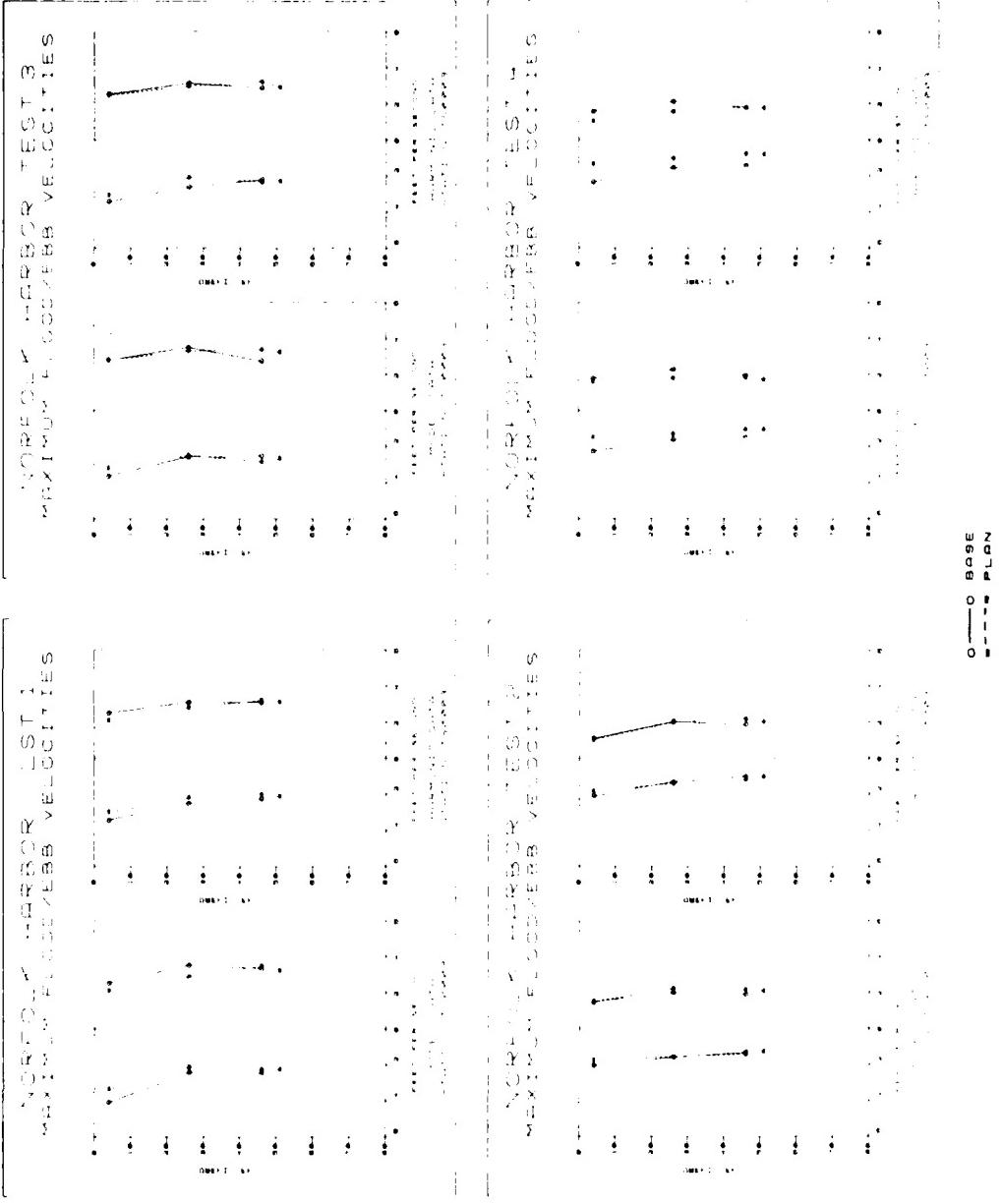


PLATE 126

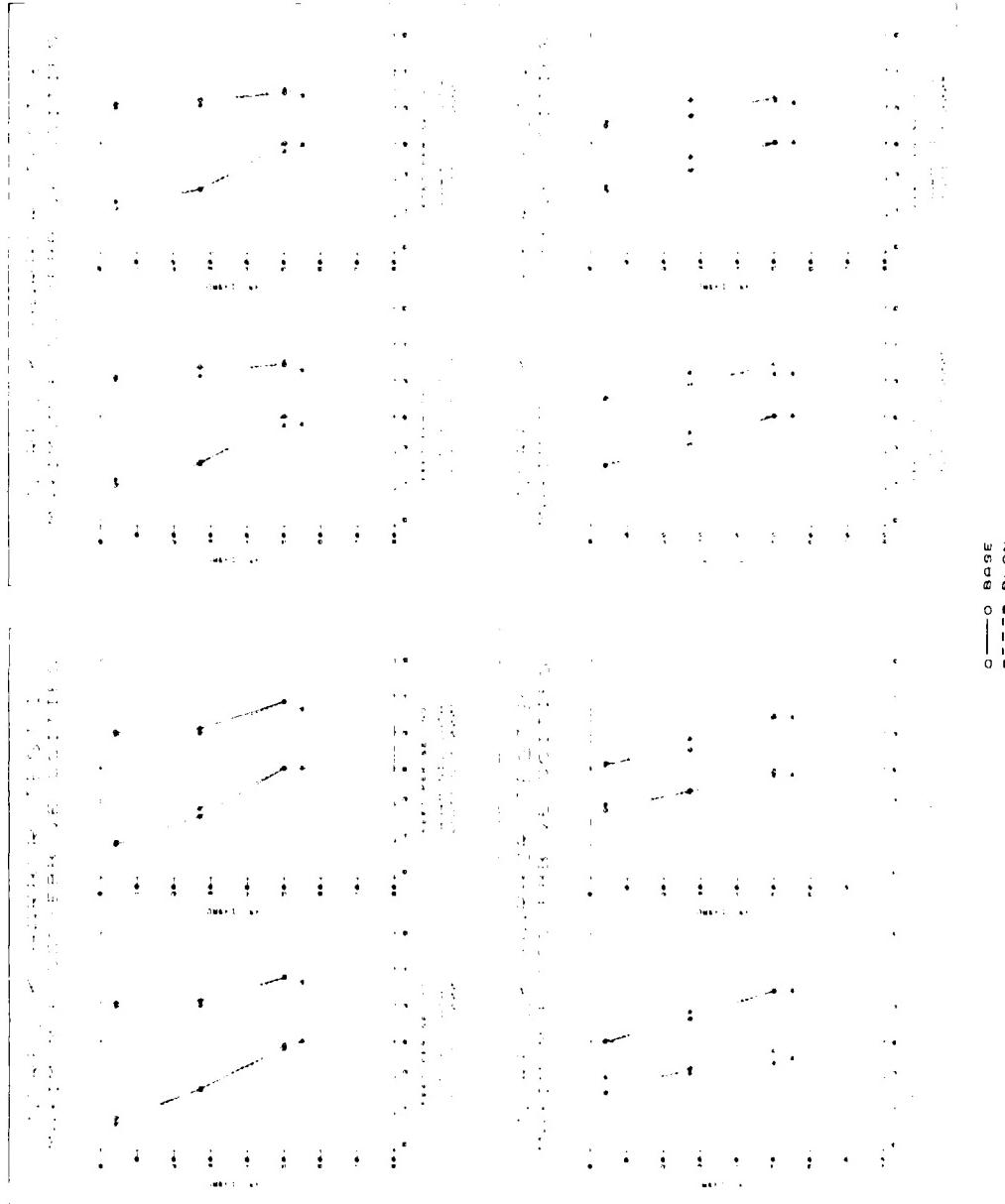


PLATE 127

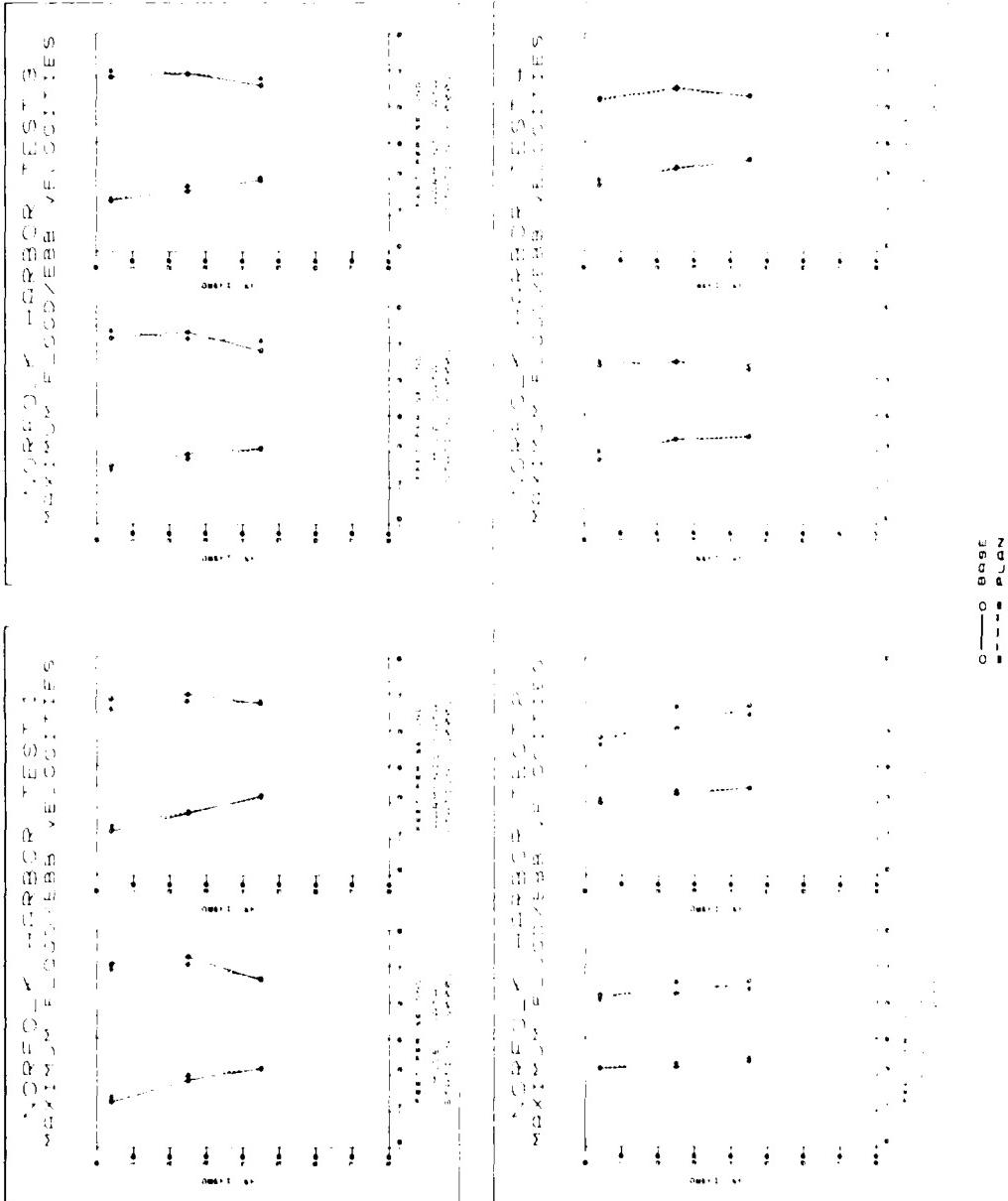


PLATE 128

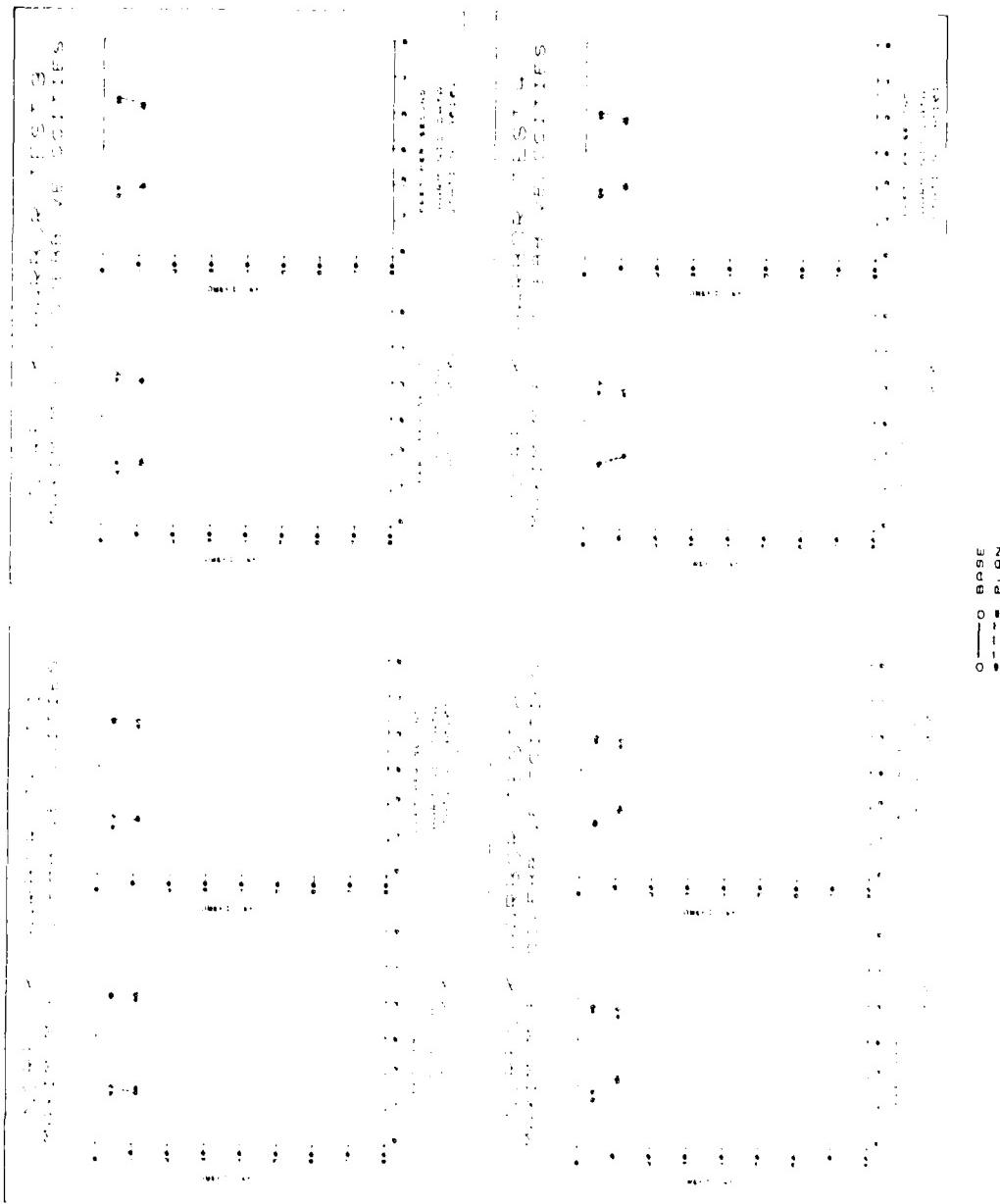


PLATE 129

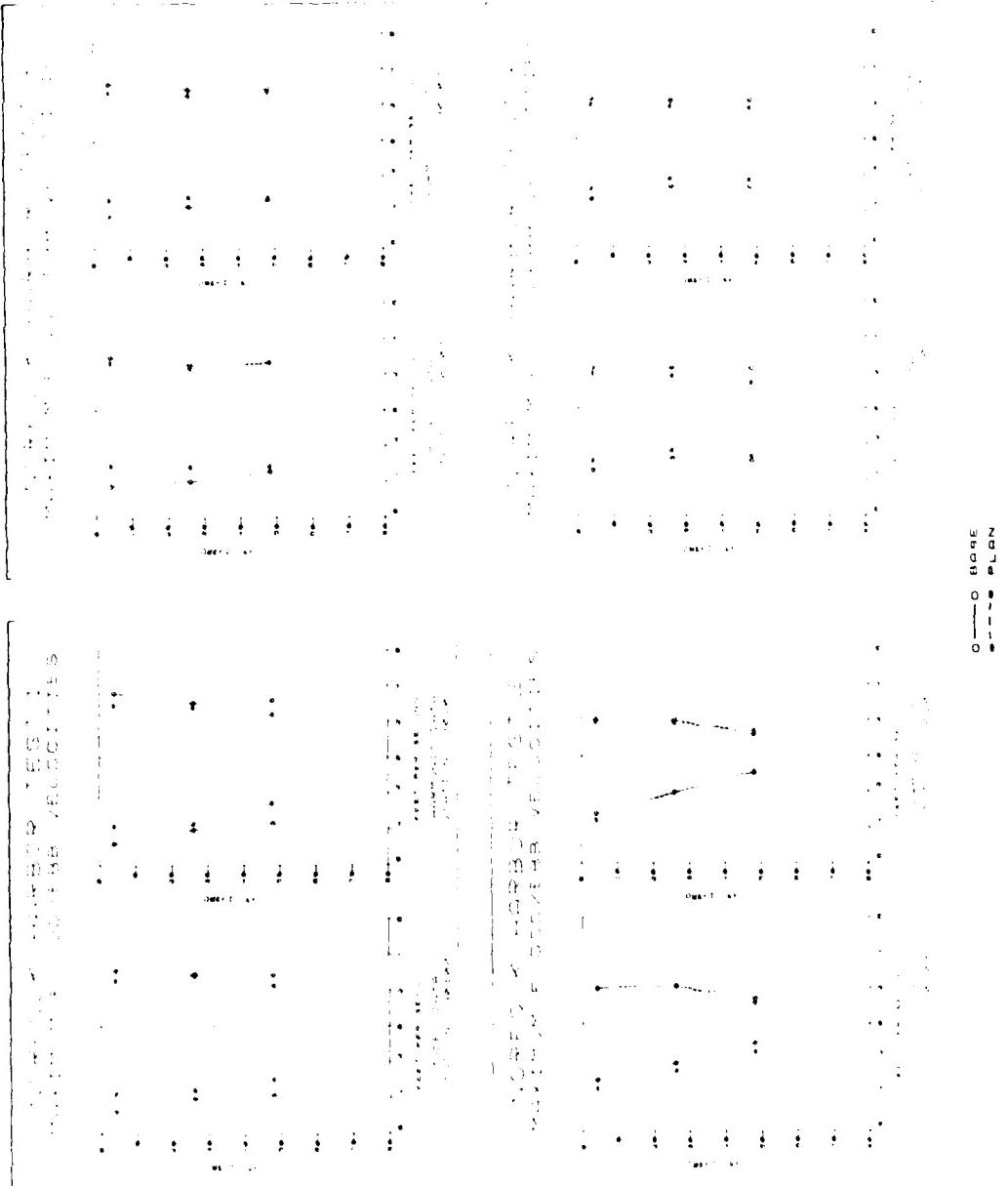


PLATE 130

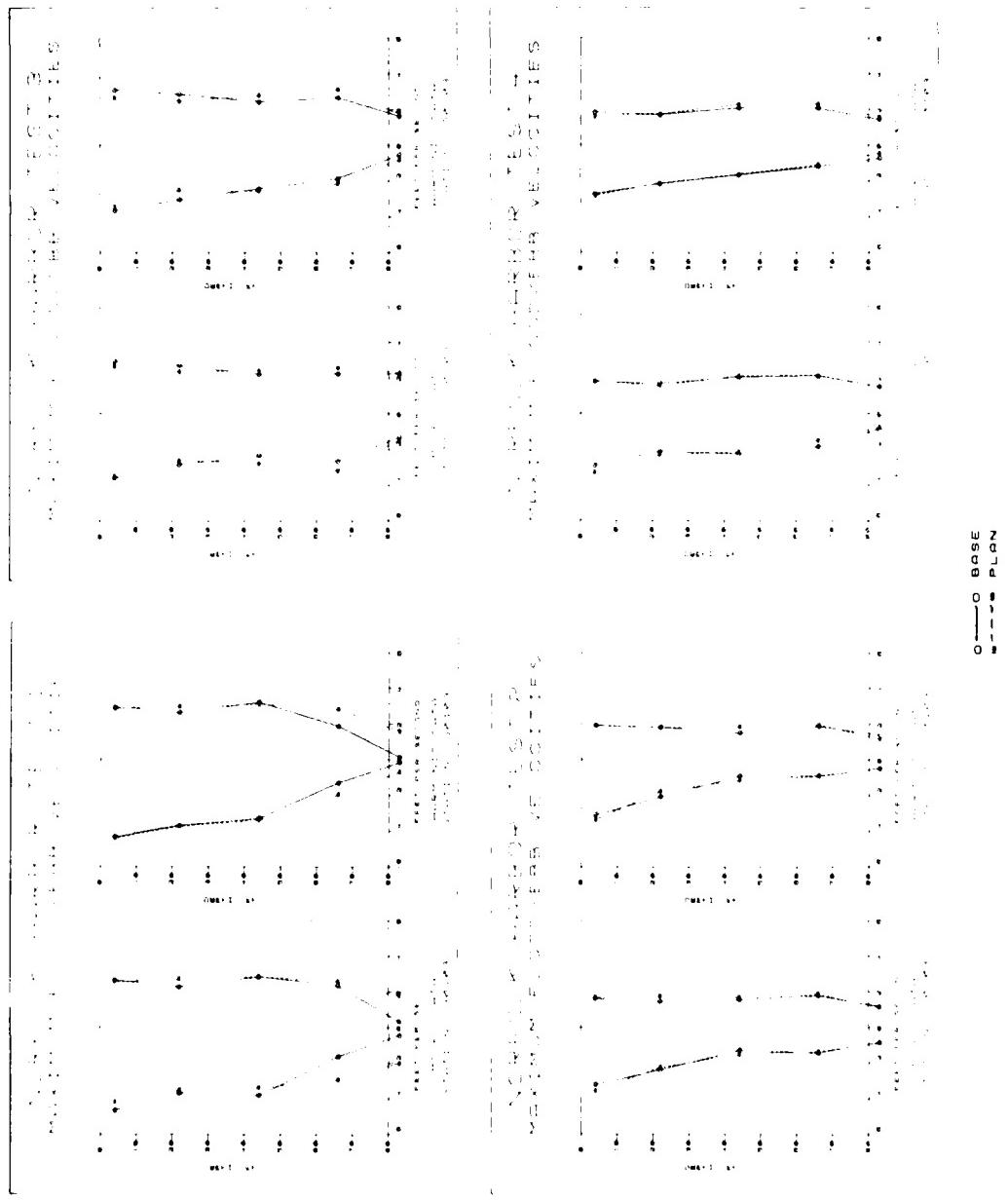


PLATE 131

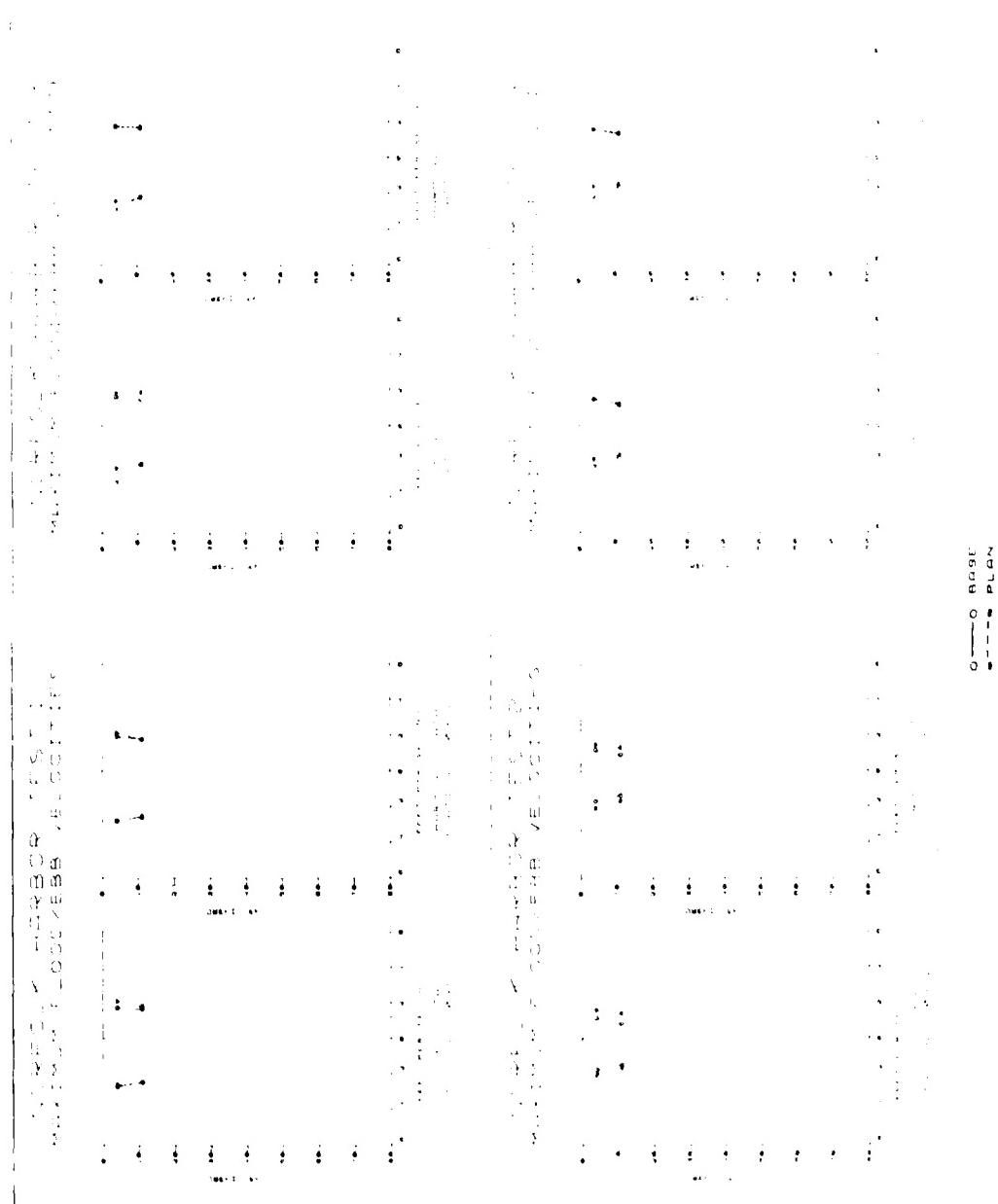


PLATE 132

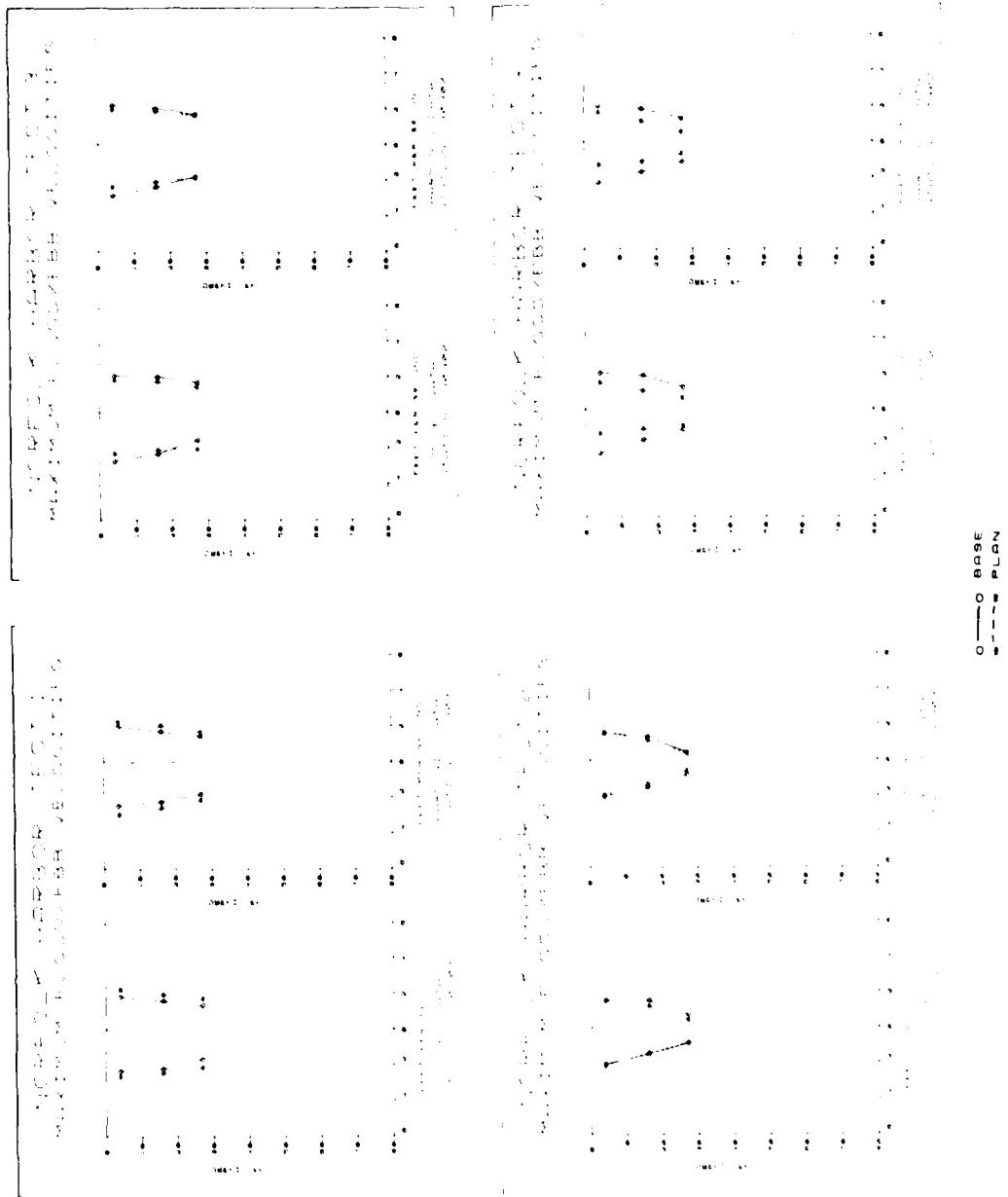
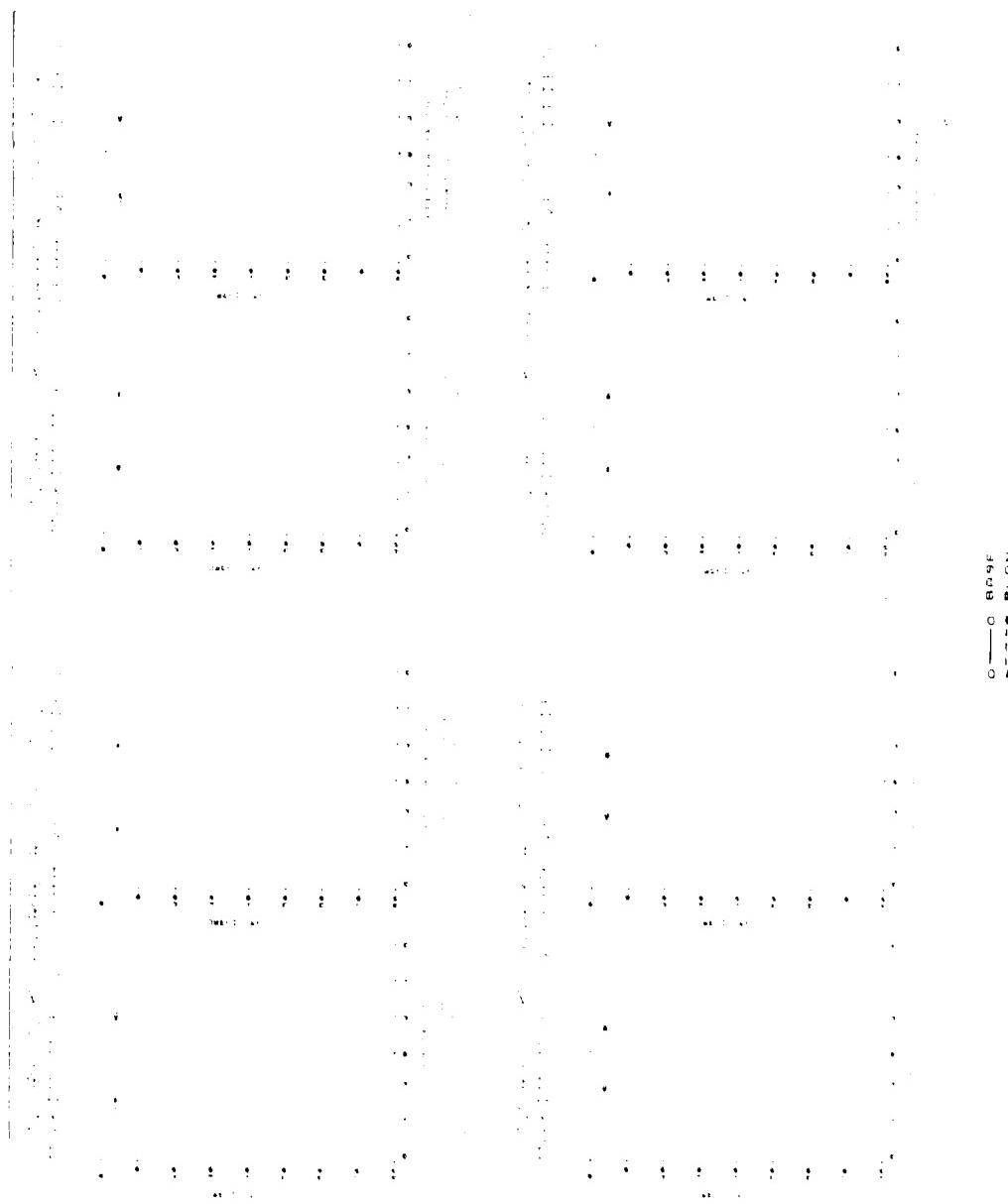


PLATE 133

PLATE 134



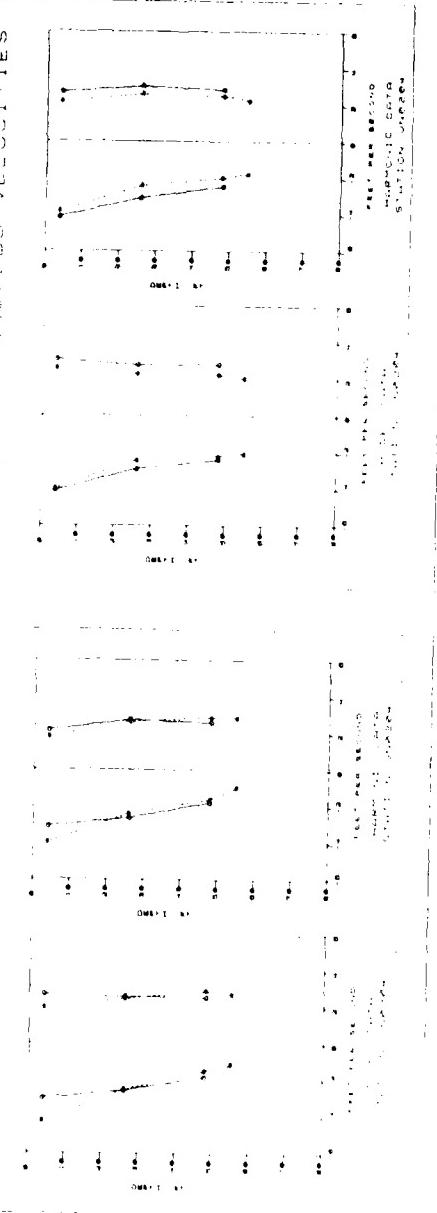
— O BASE
— O PLAN

PLATE 135

PLATE 136

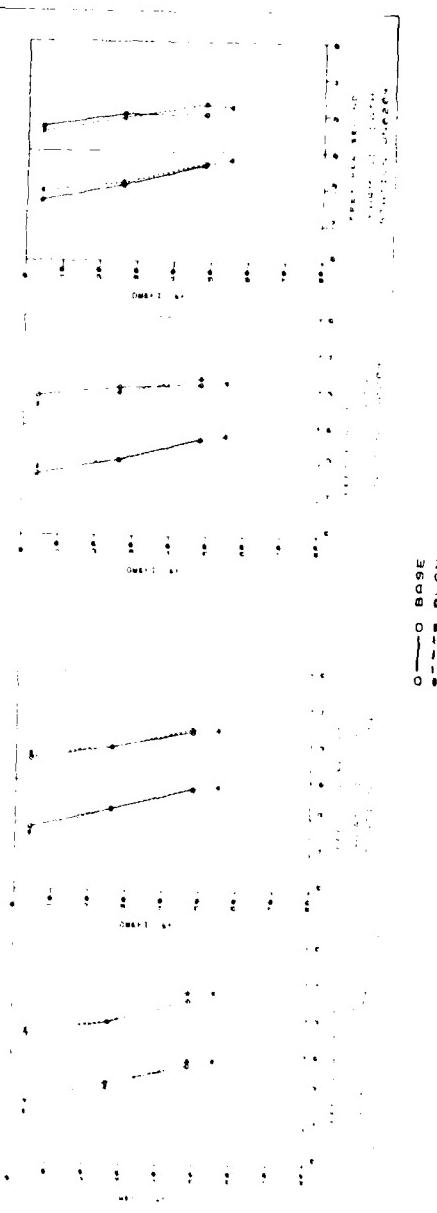
HARBOR TEST 1
MAXIMUM COKE EBB VELOCITIES

HARBOR TEST 3
MAXIMUM COKE EBB VELOCITIES



HARBOR TEST 2
MAXIMUM COKE EBB VELOCITIES

HARBOR TEST 4
MAXIMUM COKE EBB VELOCITIES



— O — BASE
— ● — PLAN

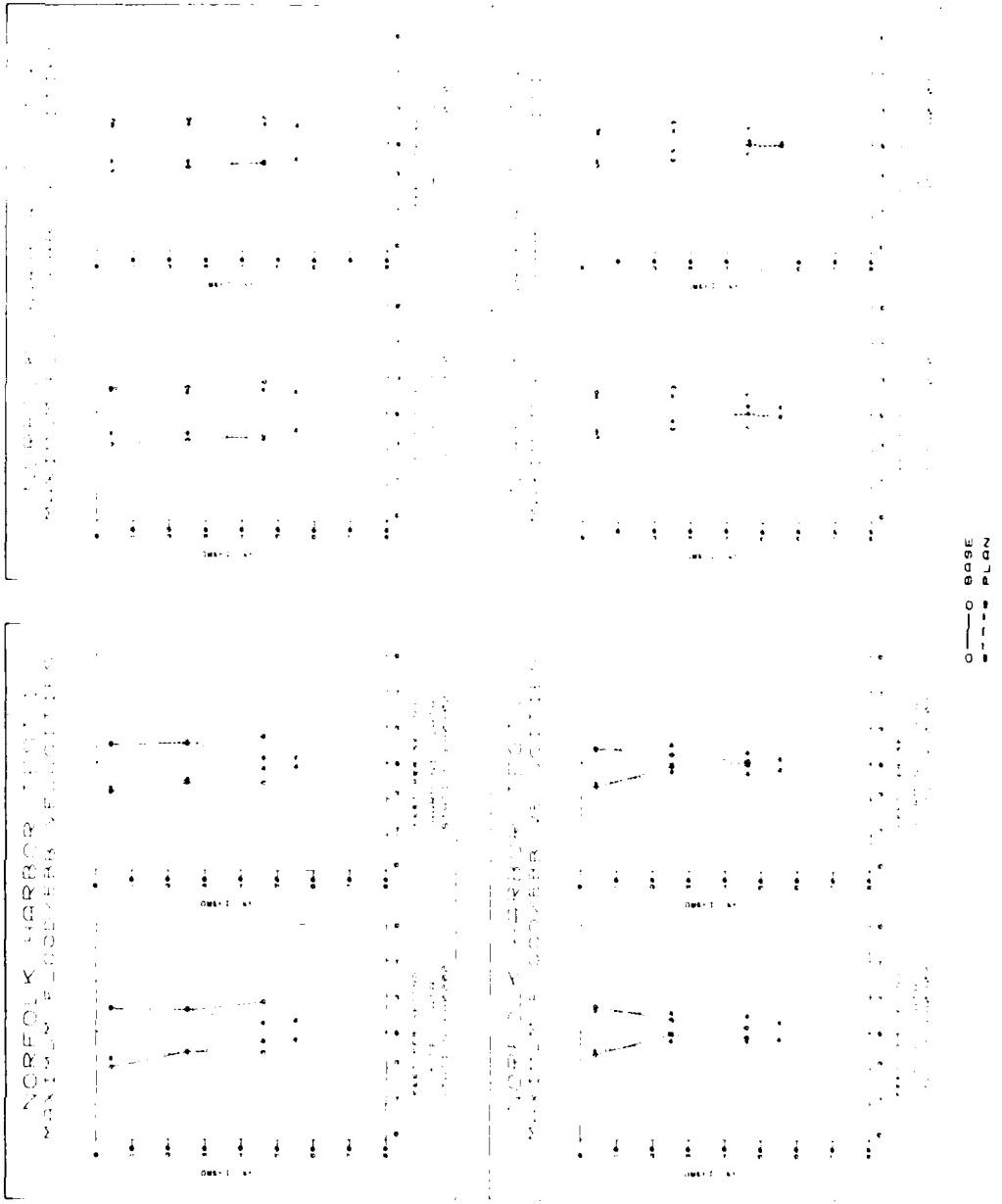


PLATE 138

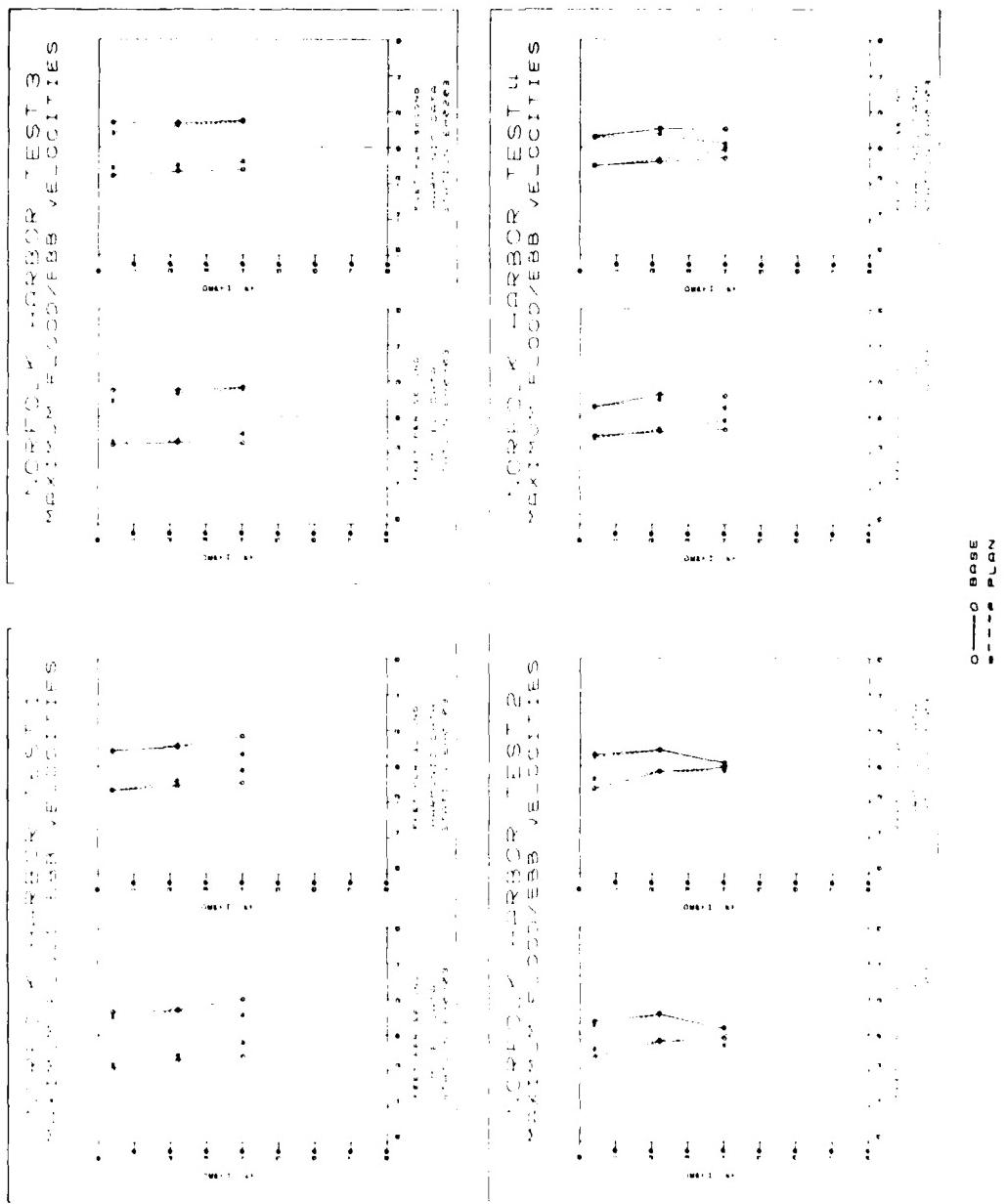
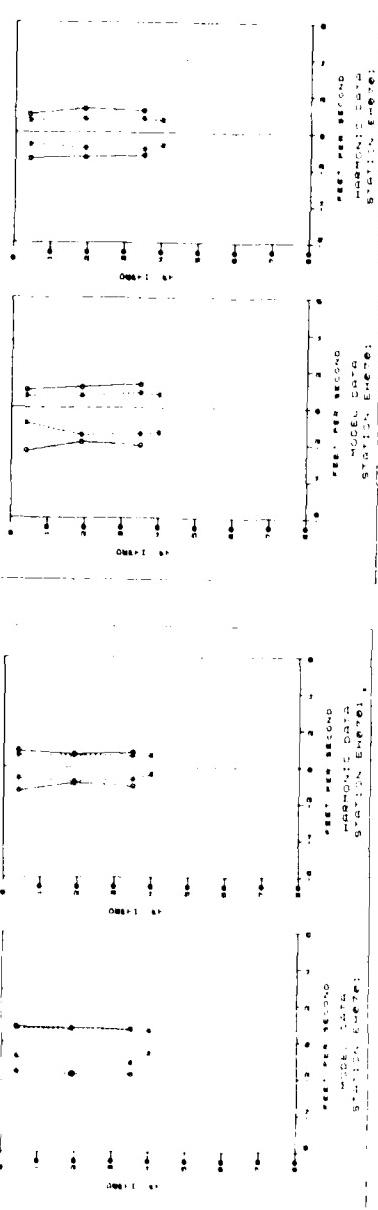


PLATE 139

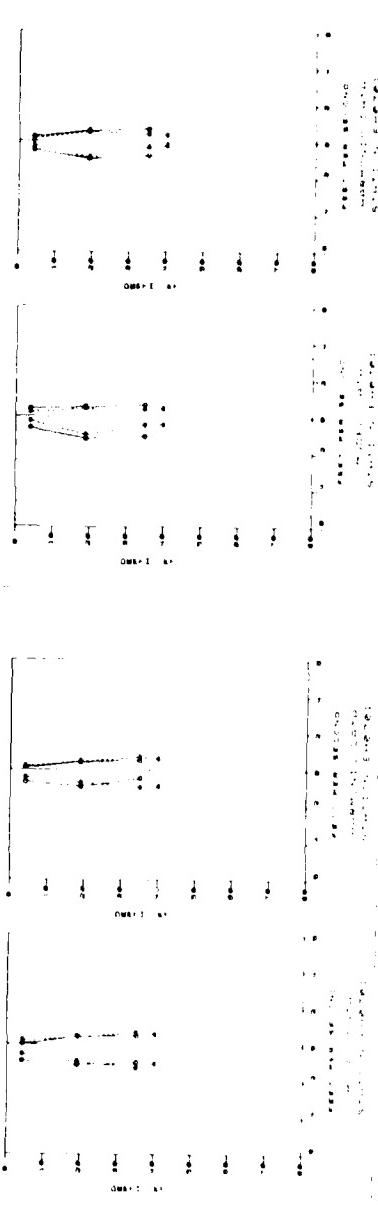
O — C Basal
— Pian

PLATE 140

NORFOLK HARBOR TEST 1
MAXIMUM FLOOD/EBB VELOCITIES

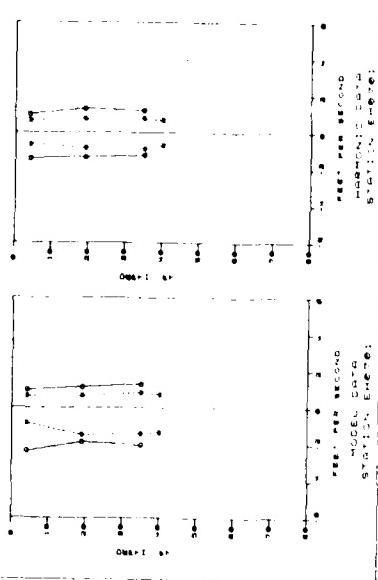


NORFOLK HARBOR TEST 2
MAXIMUM FLOOD/EBB VELOCITIES



O --- O BASE
---> PLAN

NORFOLK HARBOR TEST 3
MAXIMUM FLOOD/EBB VELOCITIES



NORFOLK HARBOR TEST 4
MAXIMUM FLOOD/EBB VELOCITIES

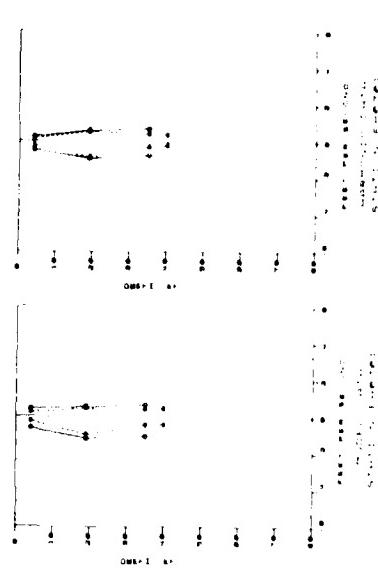
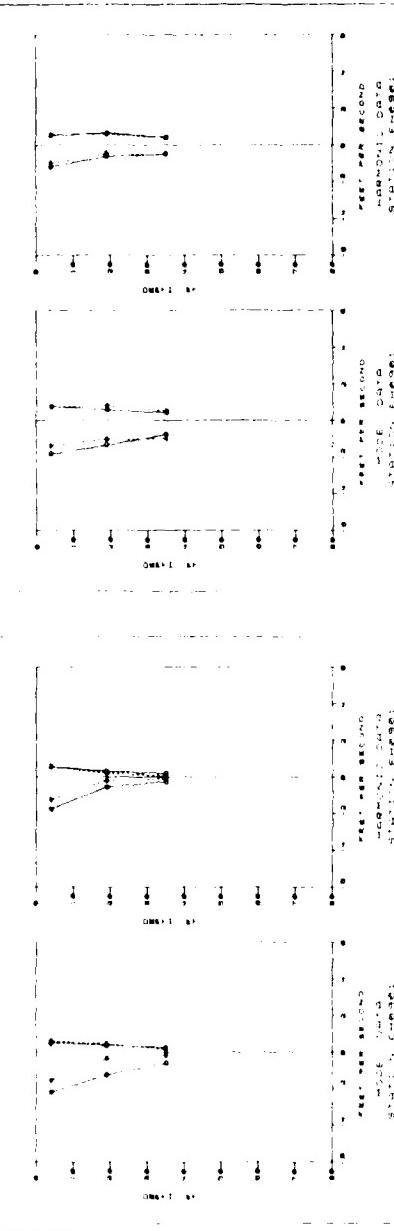


PLATE 141

NORFOLK HARBOR TEST 3
MAXIMUM FLOOD/EBB VELOCITIES



NORFOLK HARBOR TEST 4
MAXIMUM FLOOD/EBB VELOCITIES

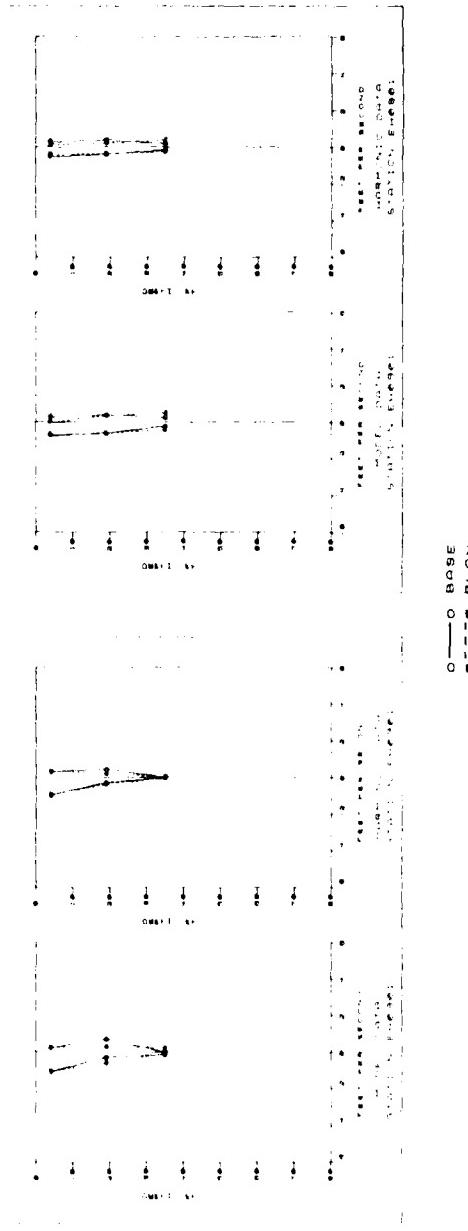
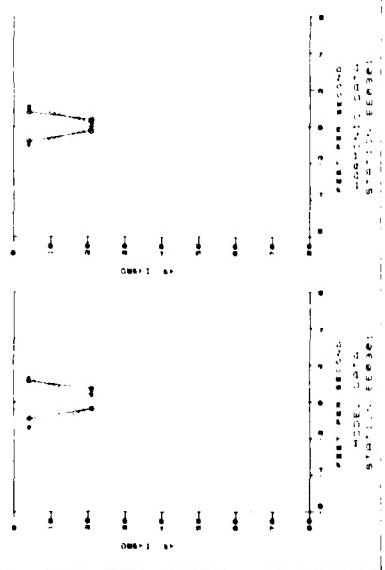
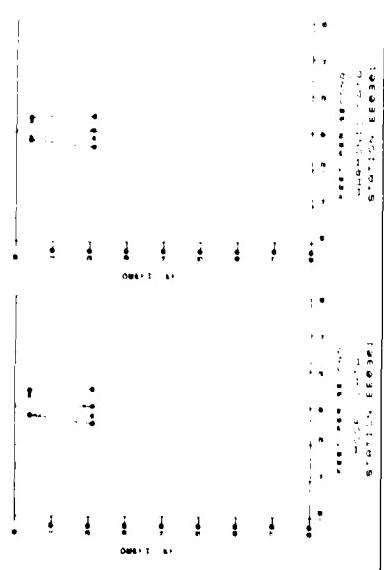


PLATE 142

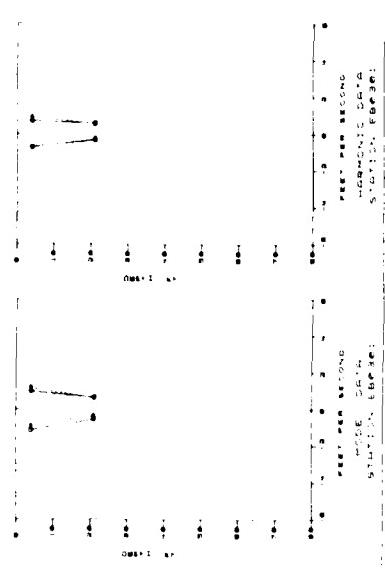
OPEN CHANNEL TESTS
MAXIMUM FLOOD/ebb velocities



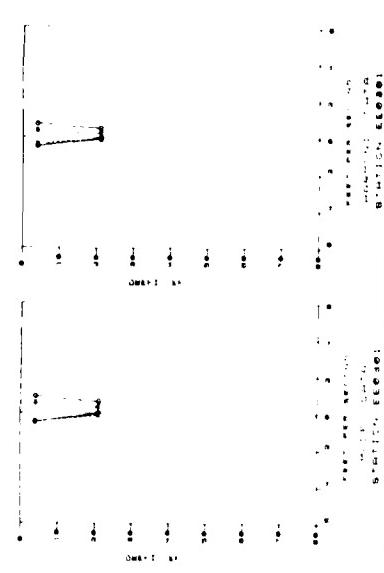
OPEN CHANNEL TESTS
MAXIMUM FLOOD/ebb velocities



OPEN CHANNEL TESTS
MAXIMUM FLOOD/ebb velocities



OPEN CHANNEL TESTS
MAXIMUM FLOOD/ebb velocities



O --- BASE
— — PLAN

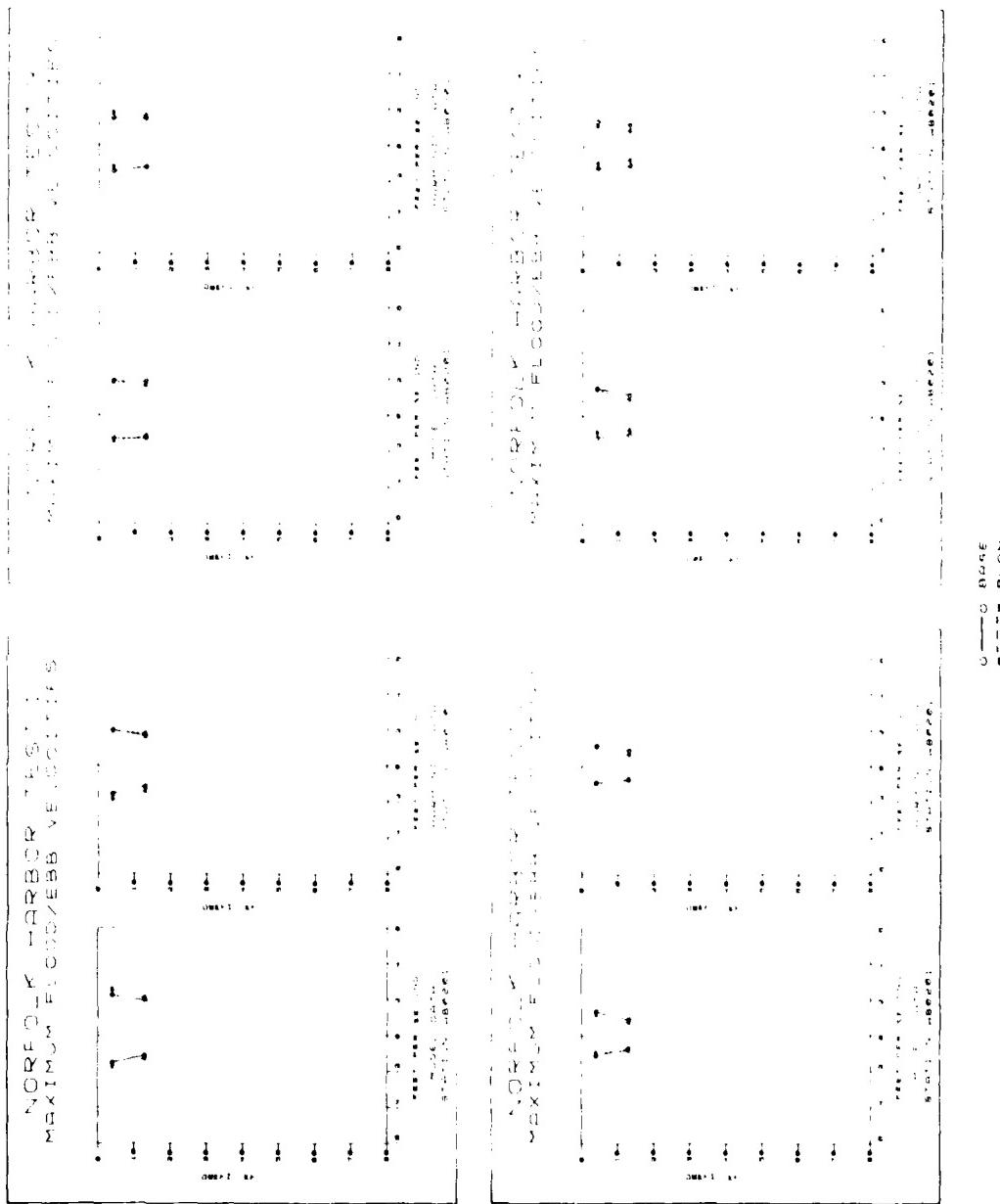


PLATE 144

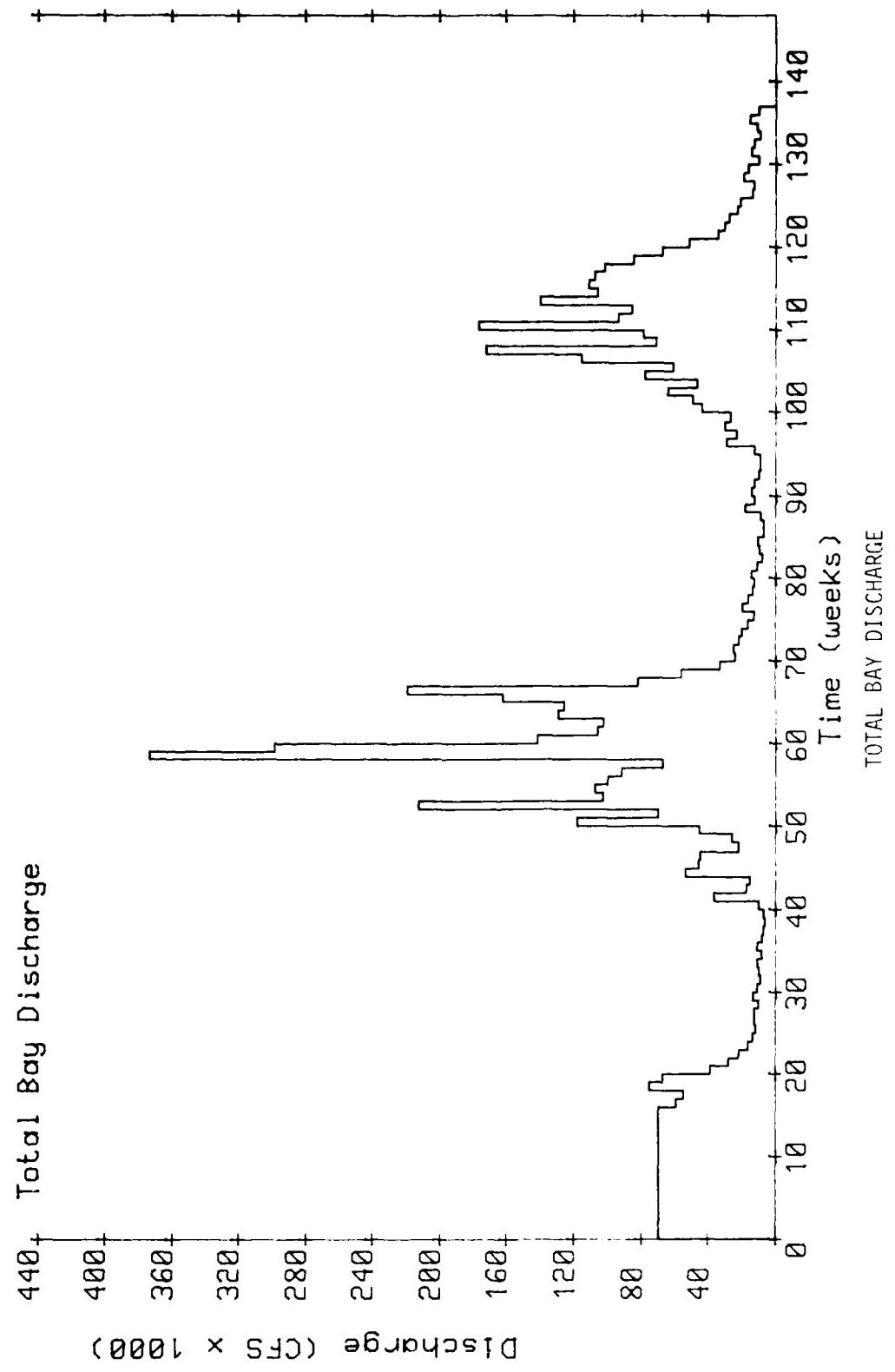
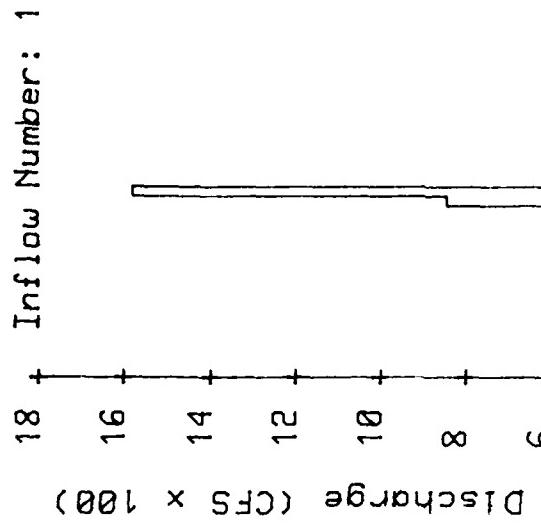


PLATE 145

PLATE 146



NANSEMOND RIVER DISCHARGE
Time (weeks)

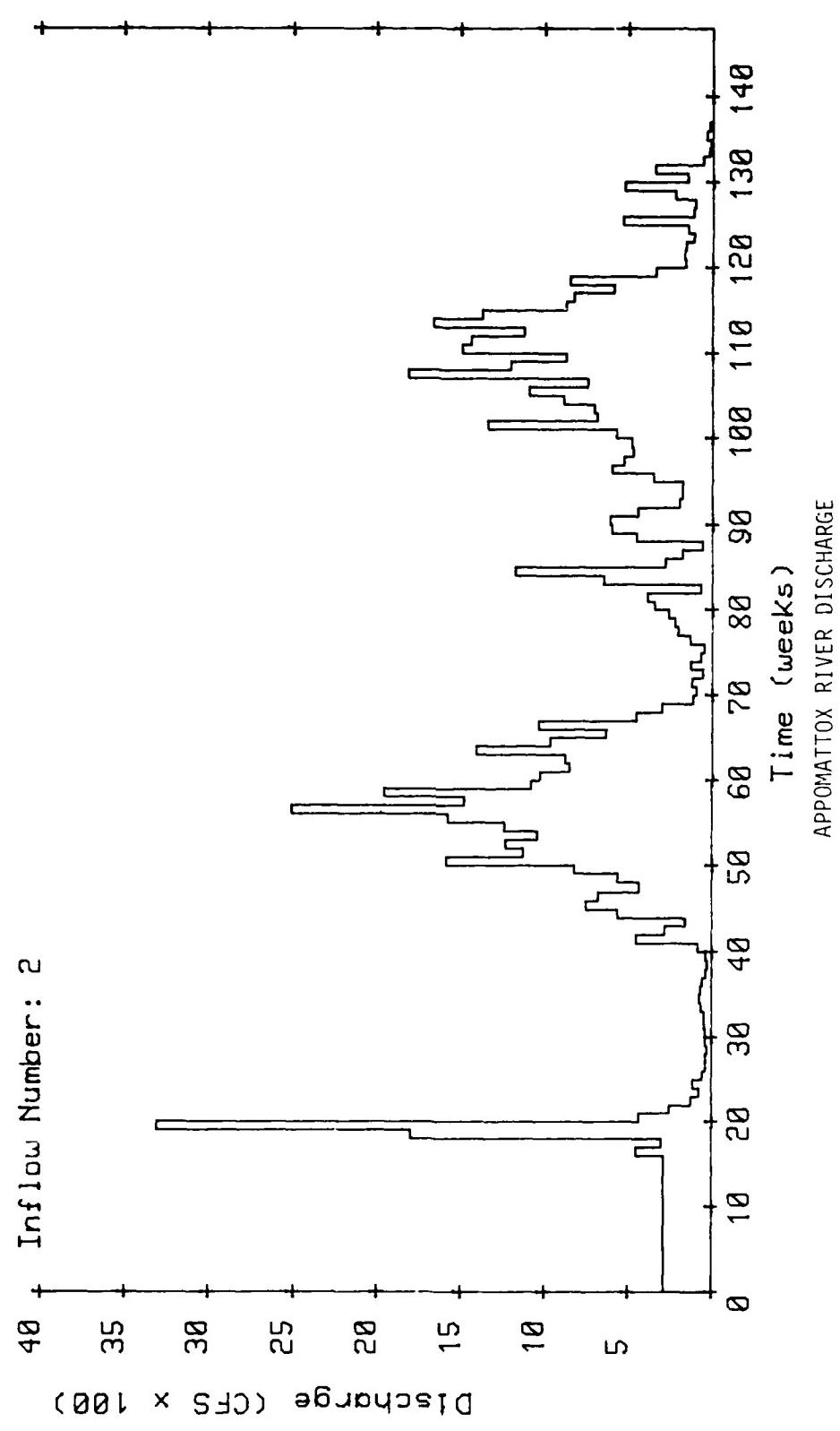


PLATE 147

Inflow Number: 3

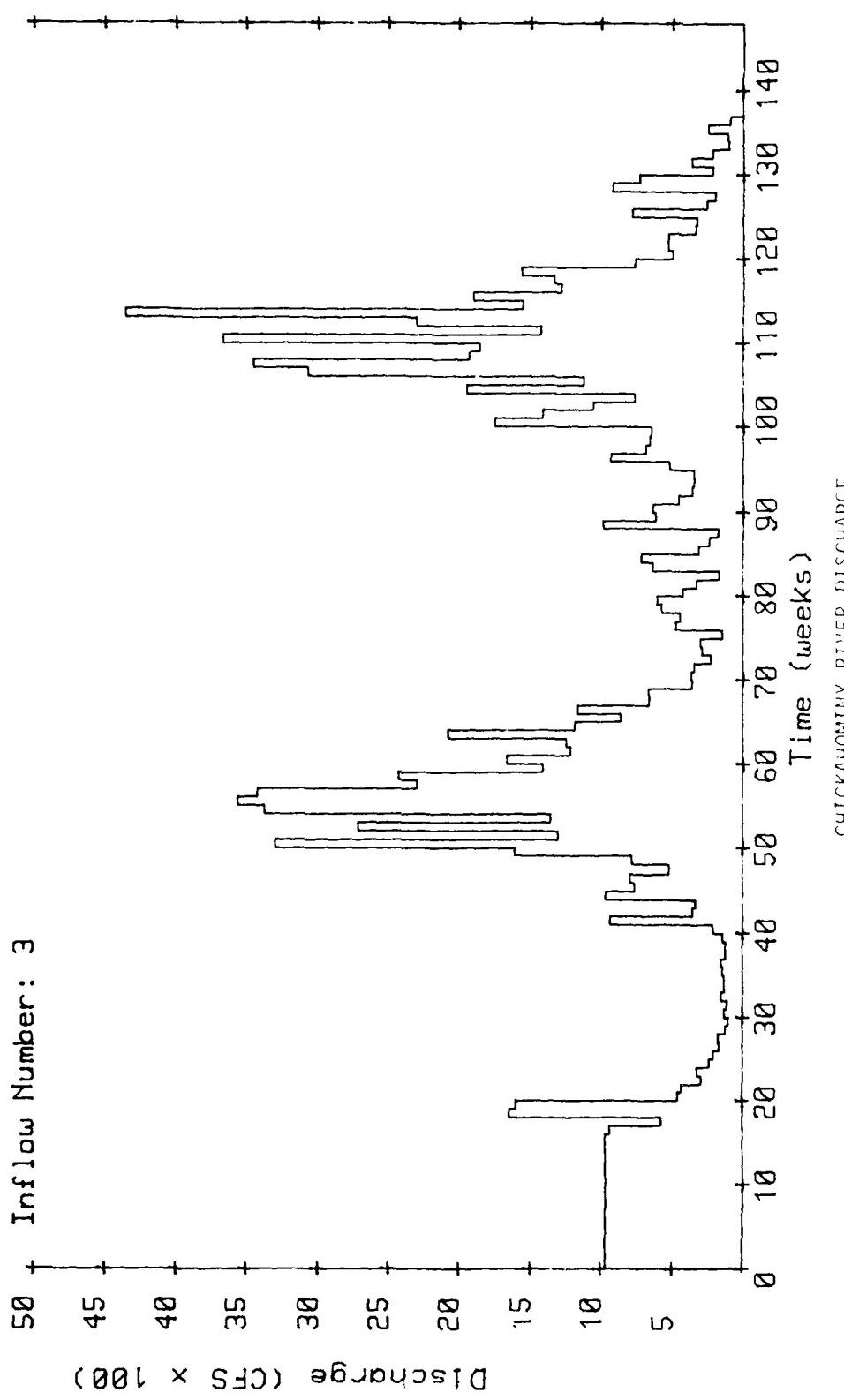


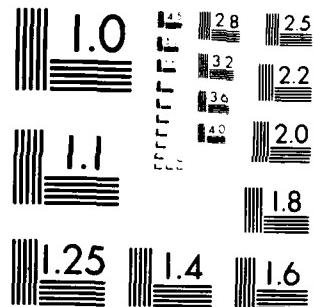
PLATE 148

AD-A134 563 NORFOLK HARBOR AND CHANNELS DEEPENING STUDY REPORT 1
PHYSICAL MODEL RESULTS (U) ARMY ENGINEER WATERWAYS
EXPERIMENT STATION VICKSBURG MS HYDRA-1

UNCCLASSIFIED D R RICHARDS ET AL. JUN 83 WES/TR/HL-83-13 F/G 13/2

NL

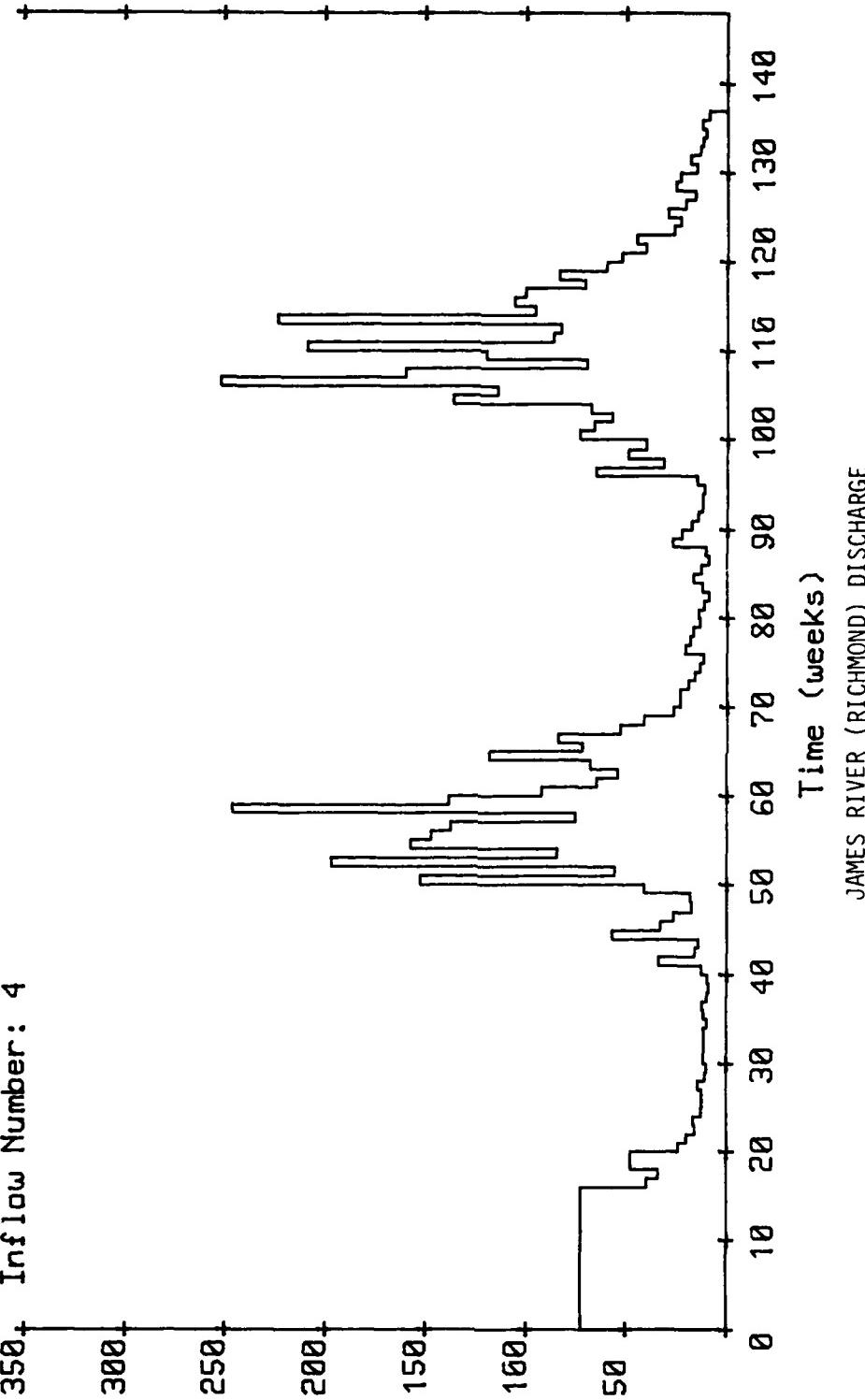
END
DATE FILMED
11-83
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

Inflow Number : 4

Discharge (CFS $\times 100$)

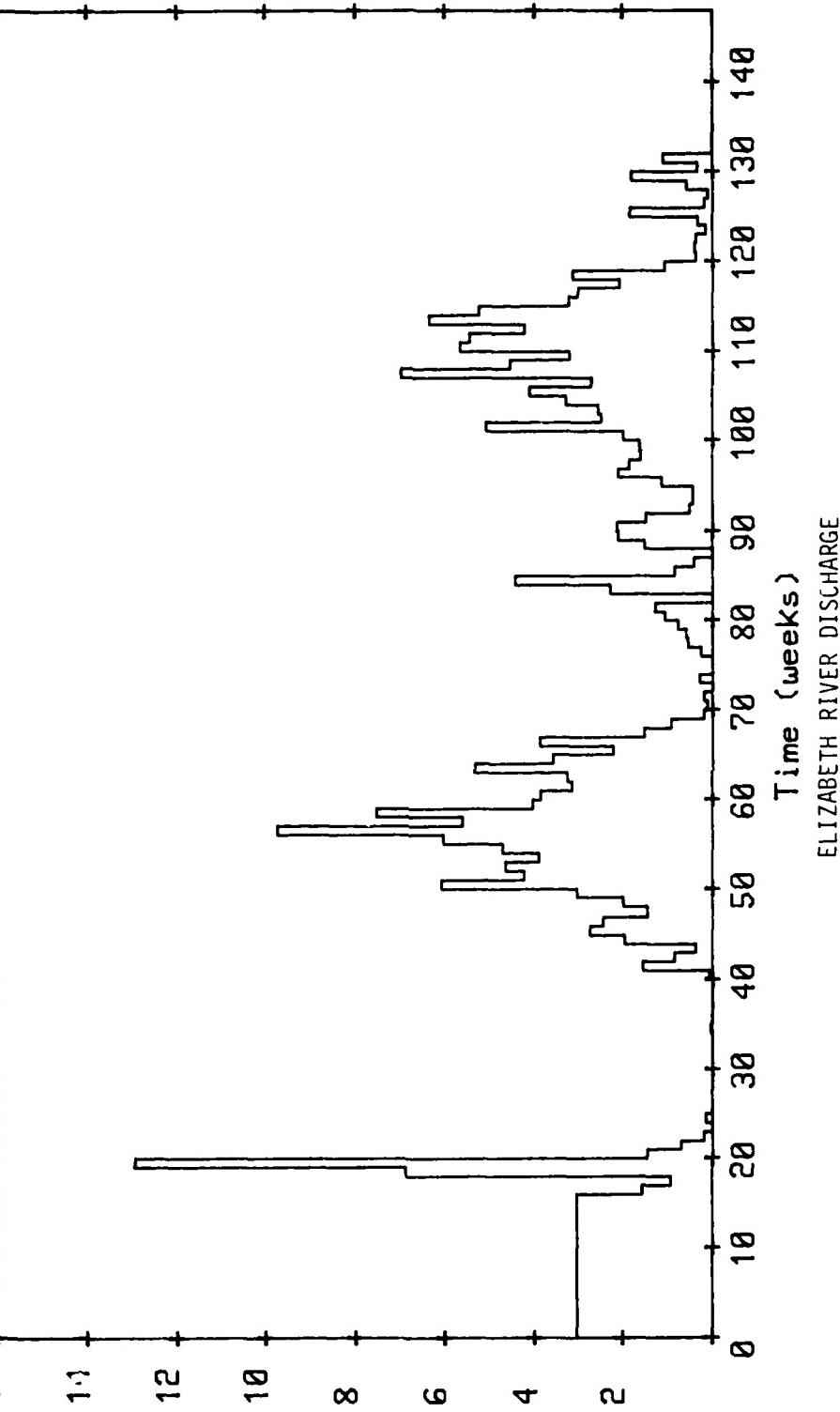


JAMES RIVER (RICHMOND) DISCHARGE

PLATE 150

Inflow Number: 23

Discharge (CFS $\times 1000$)



ELIZABETH RIVER DISCHARGE

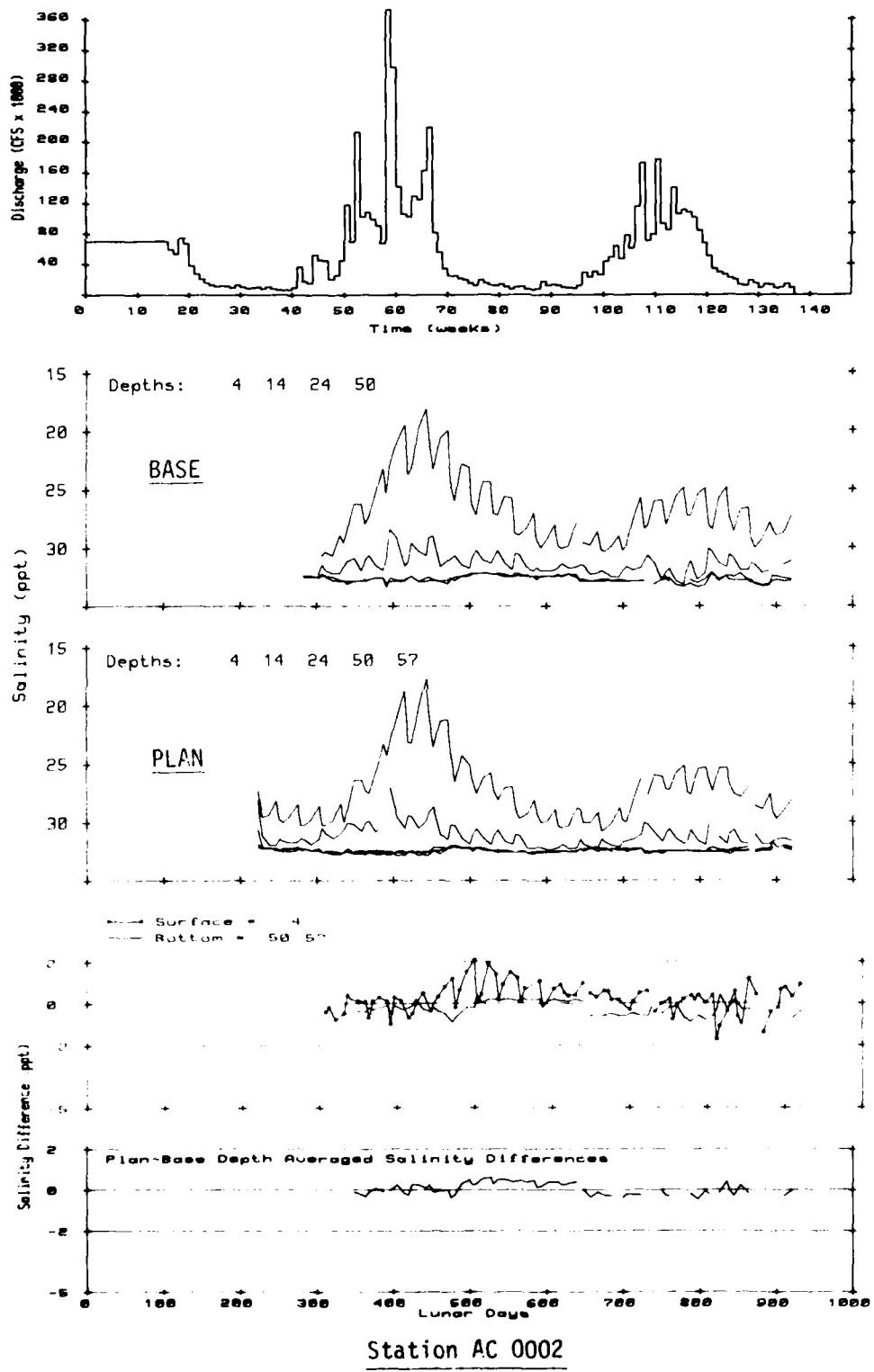


PLATE 151

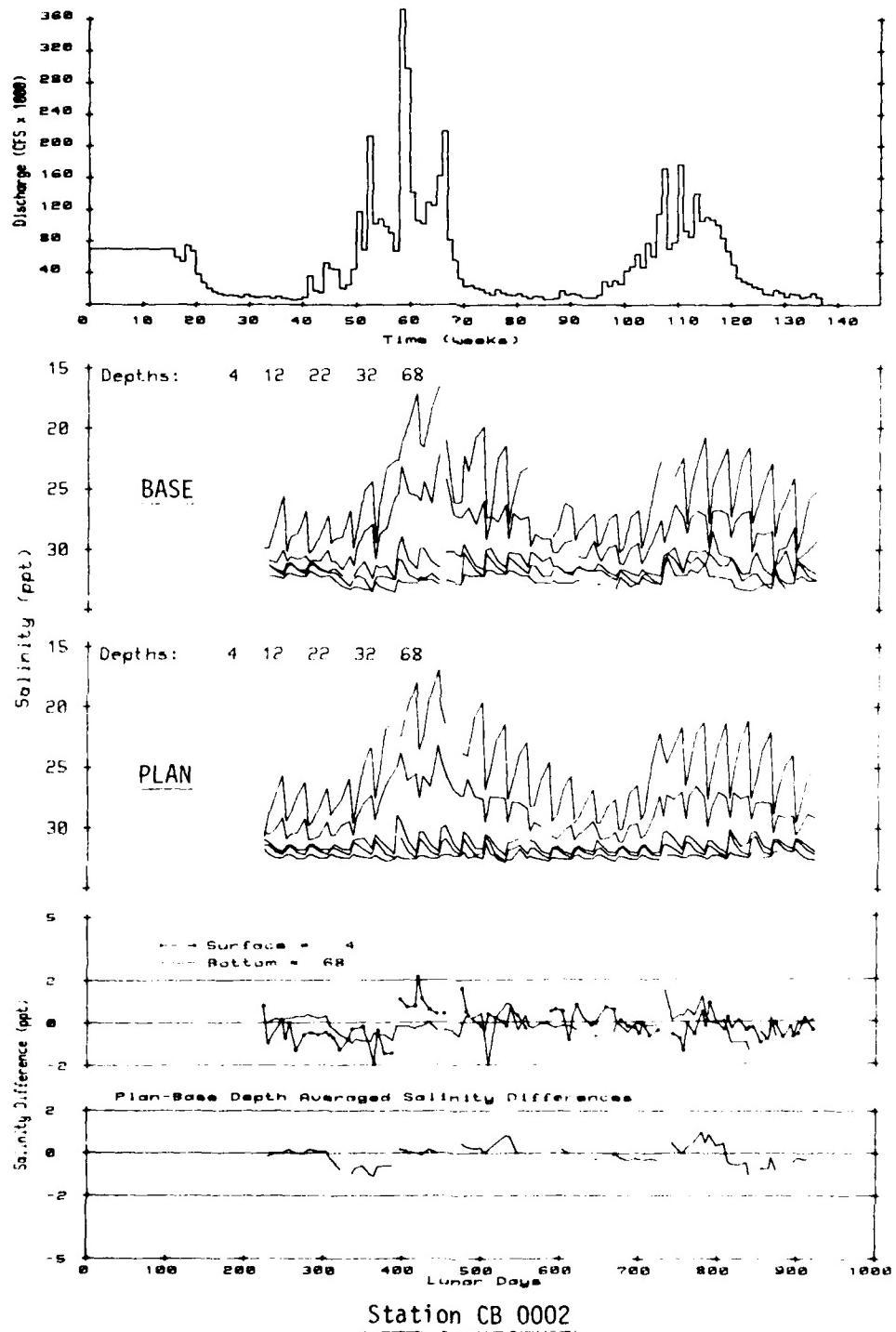


PLATE 152

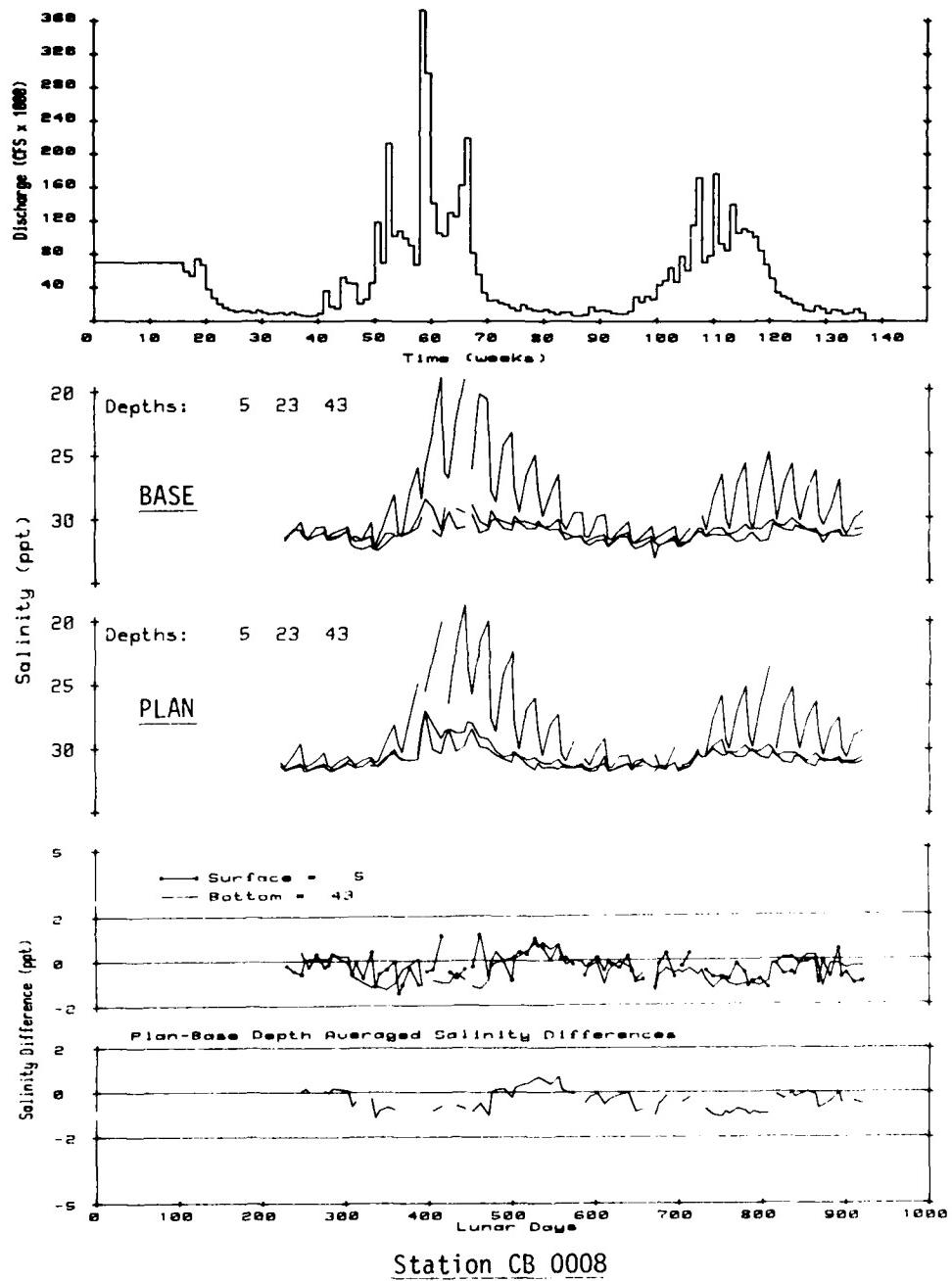


PLATE 153

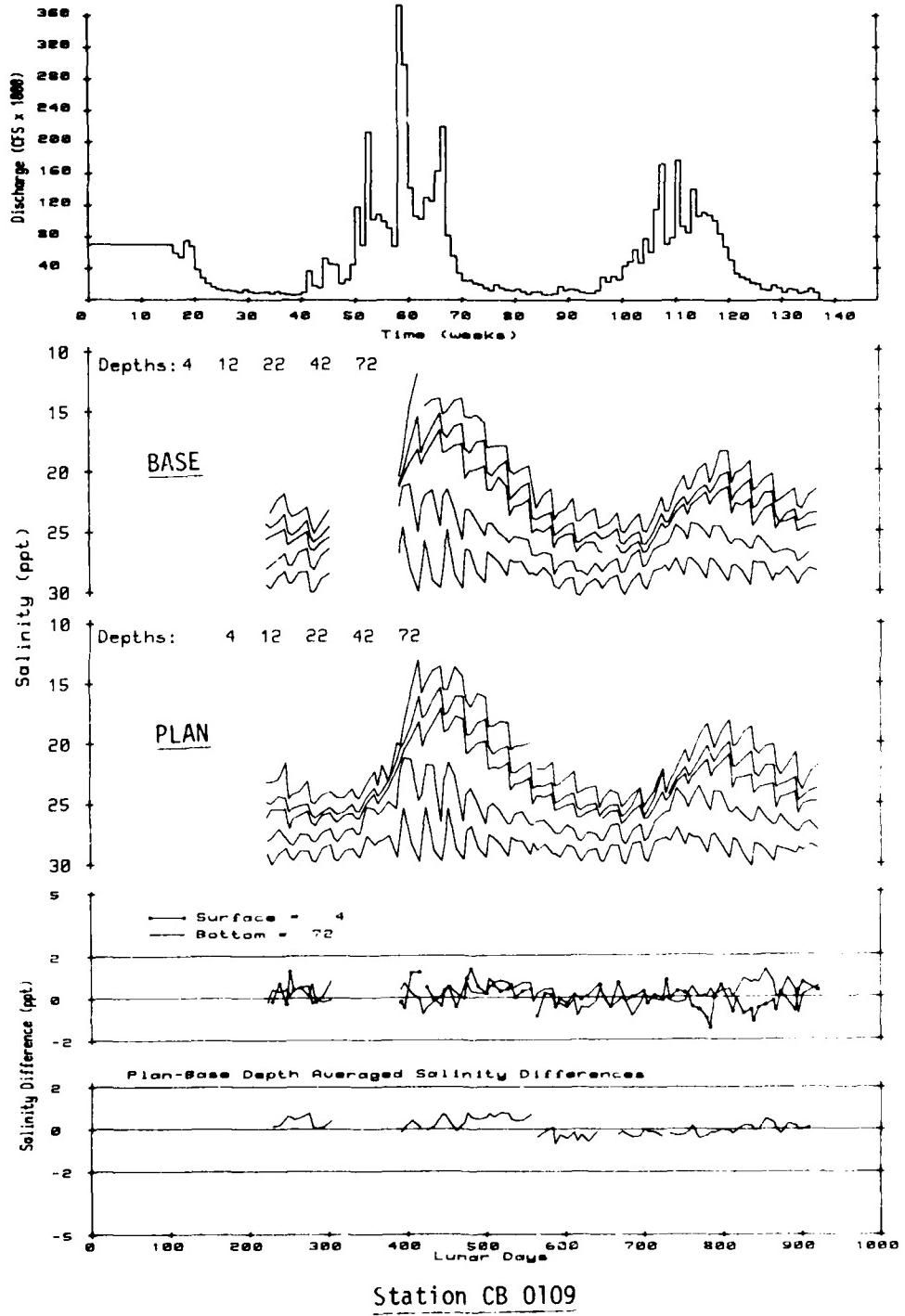
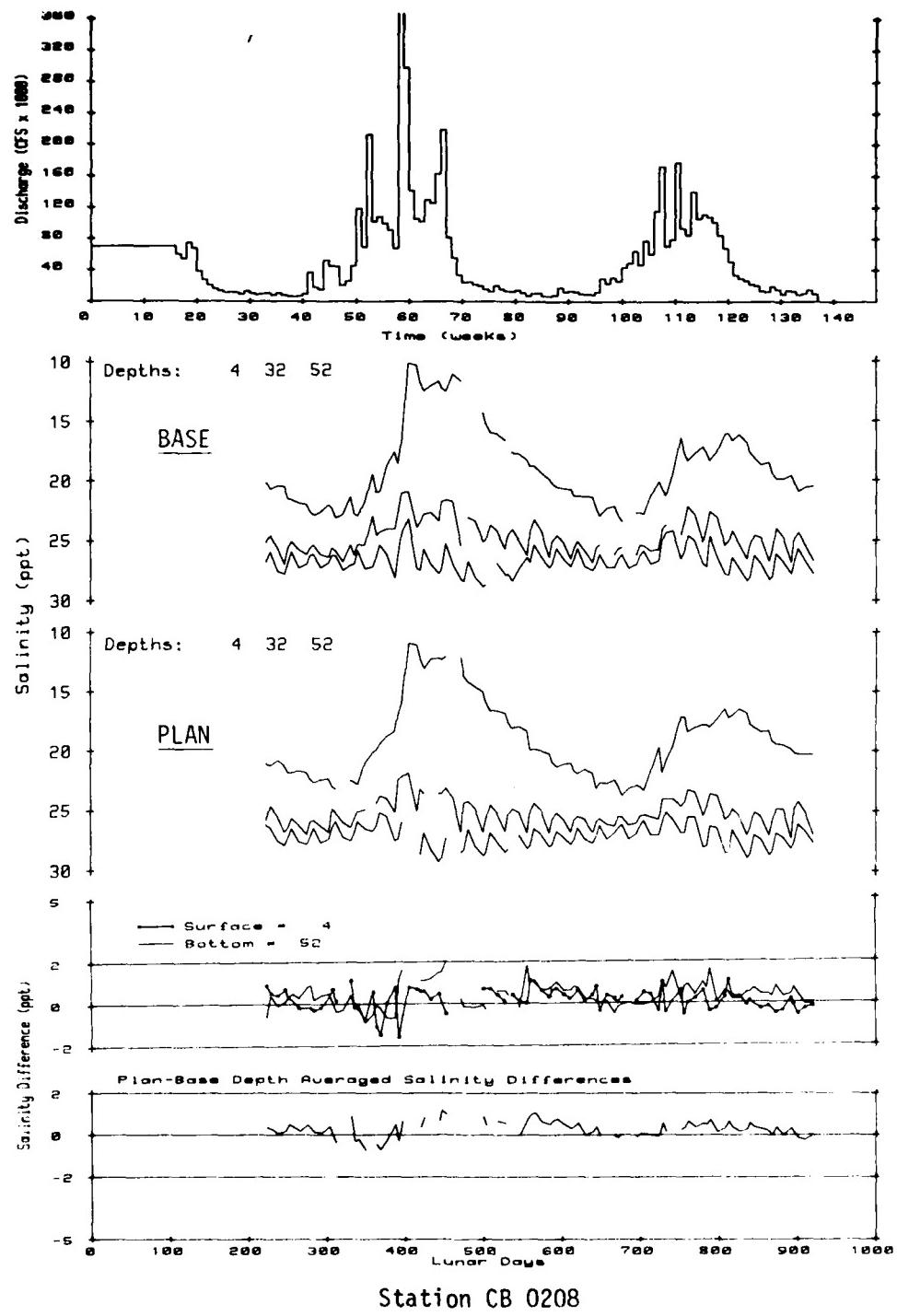


PLATE 154



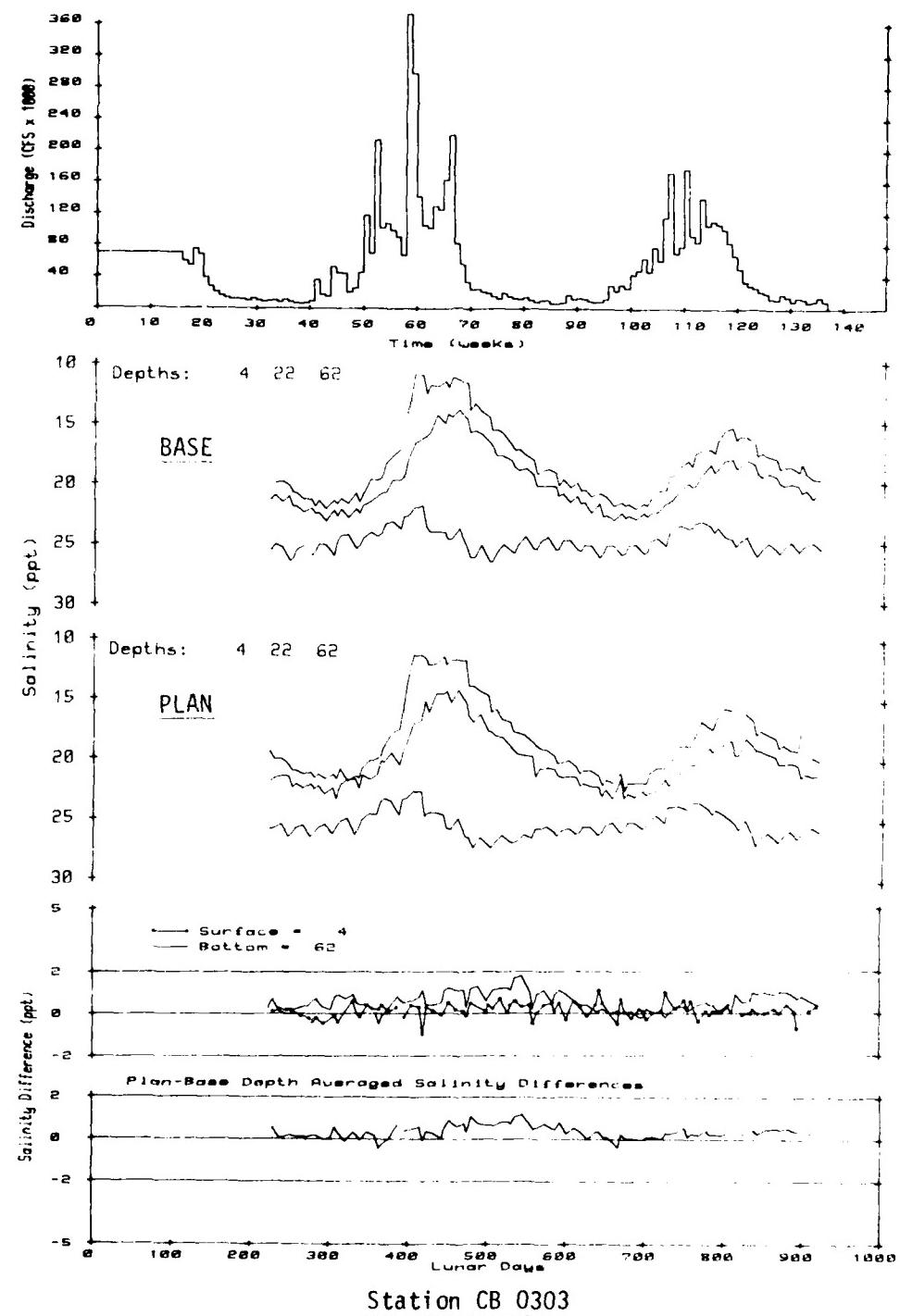
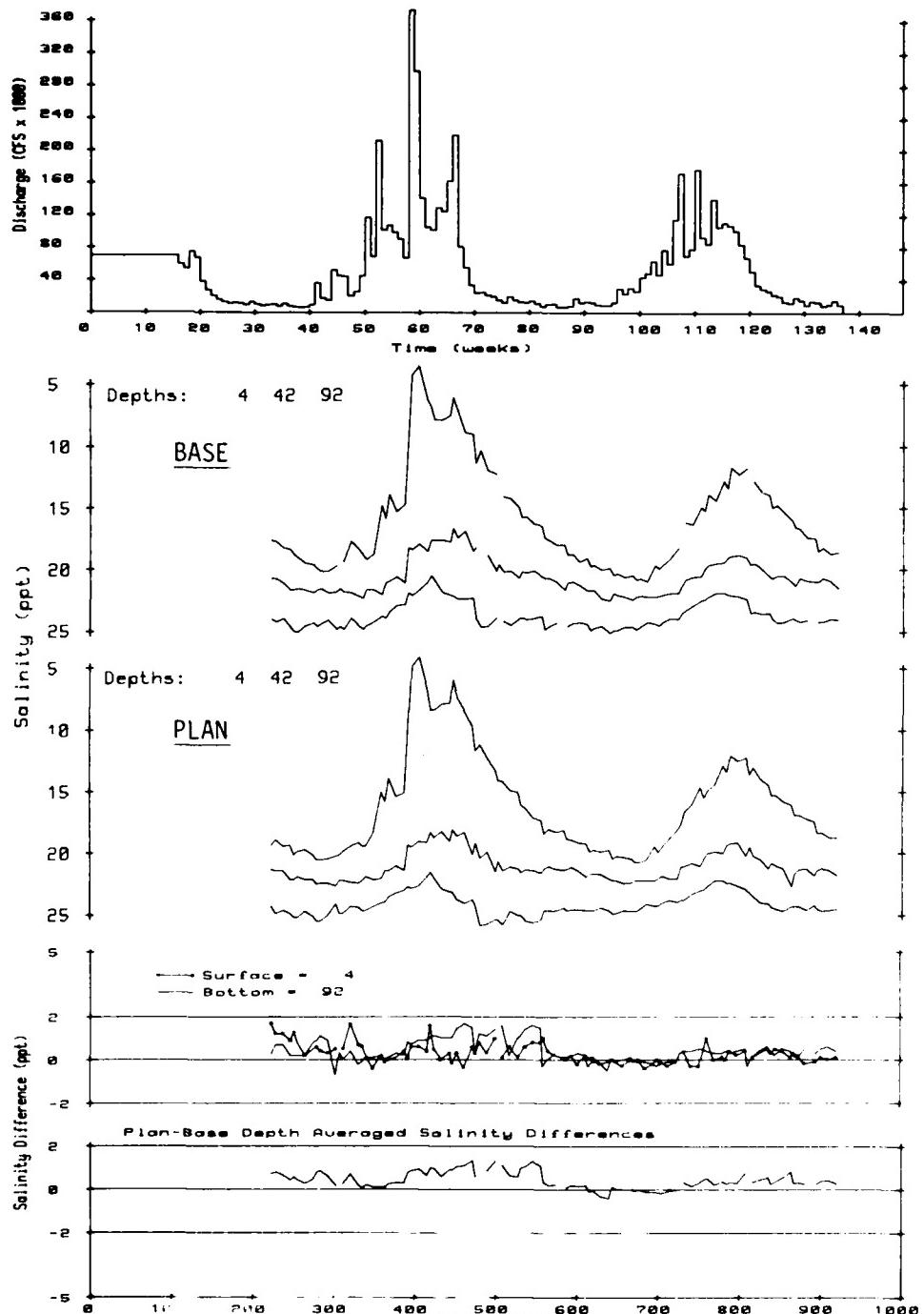
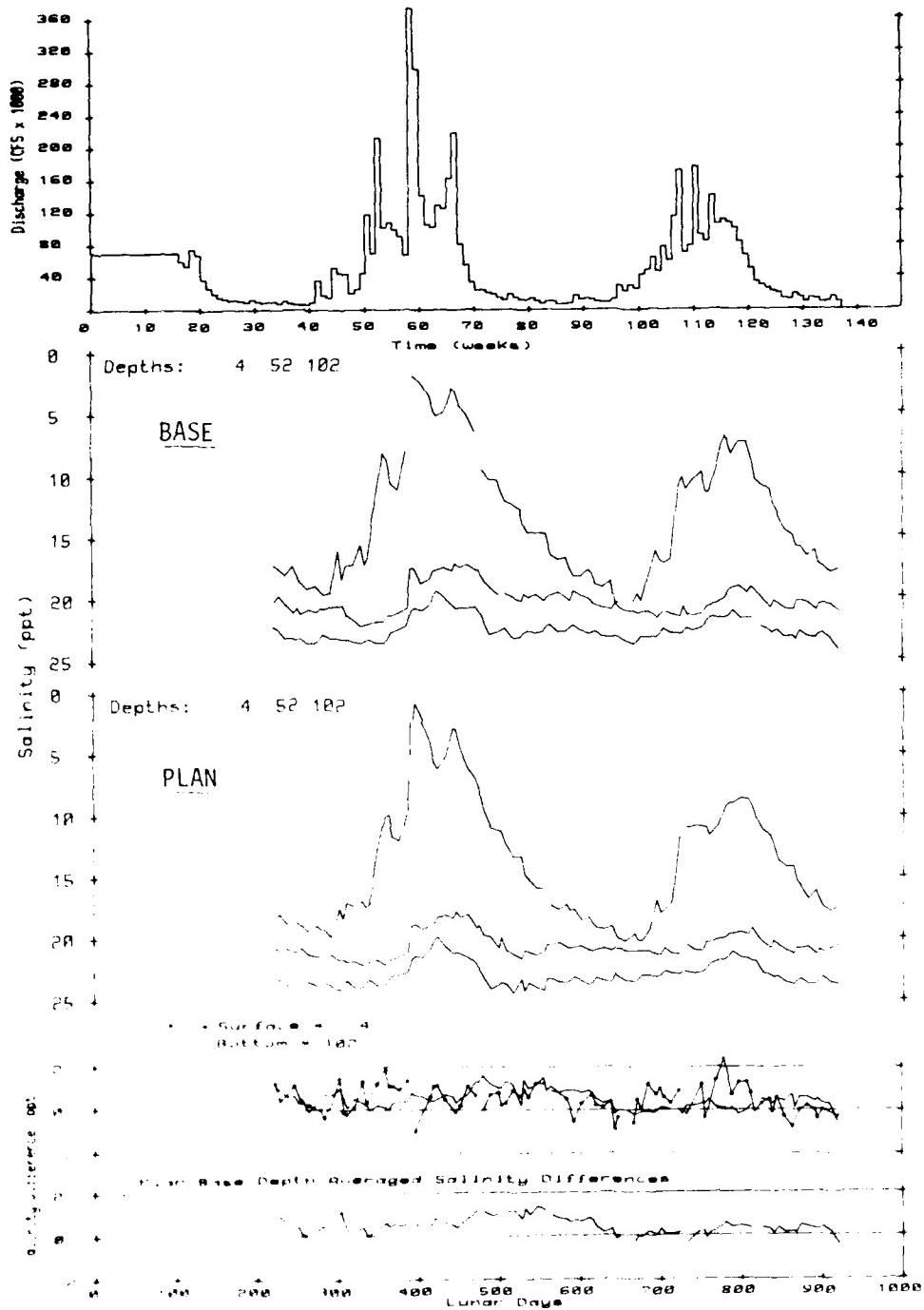


PLATE 156



Station CB 0404



Station CB 0505

PLATE 158

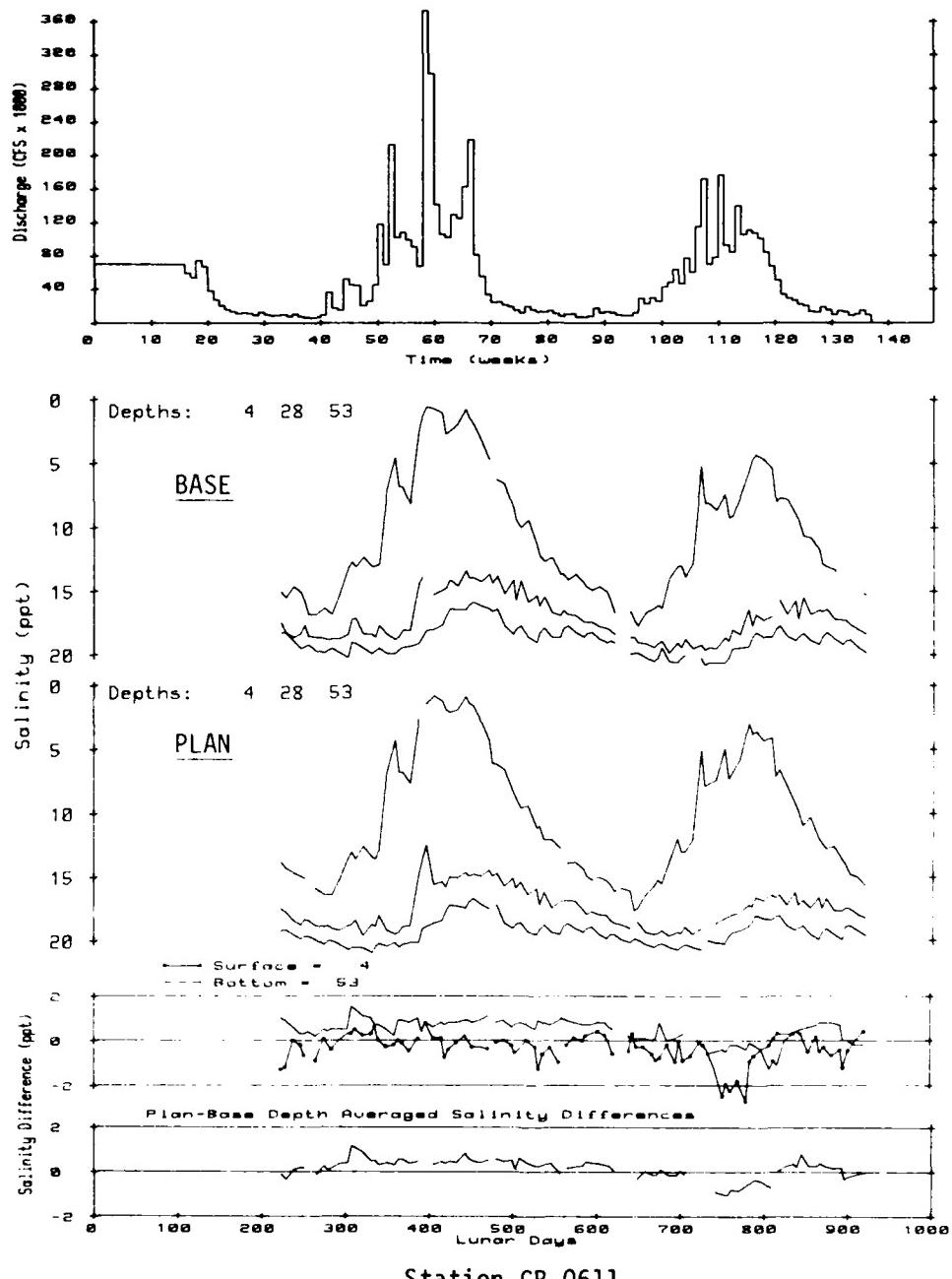


PLATE 159

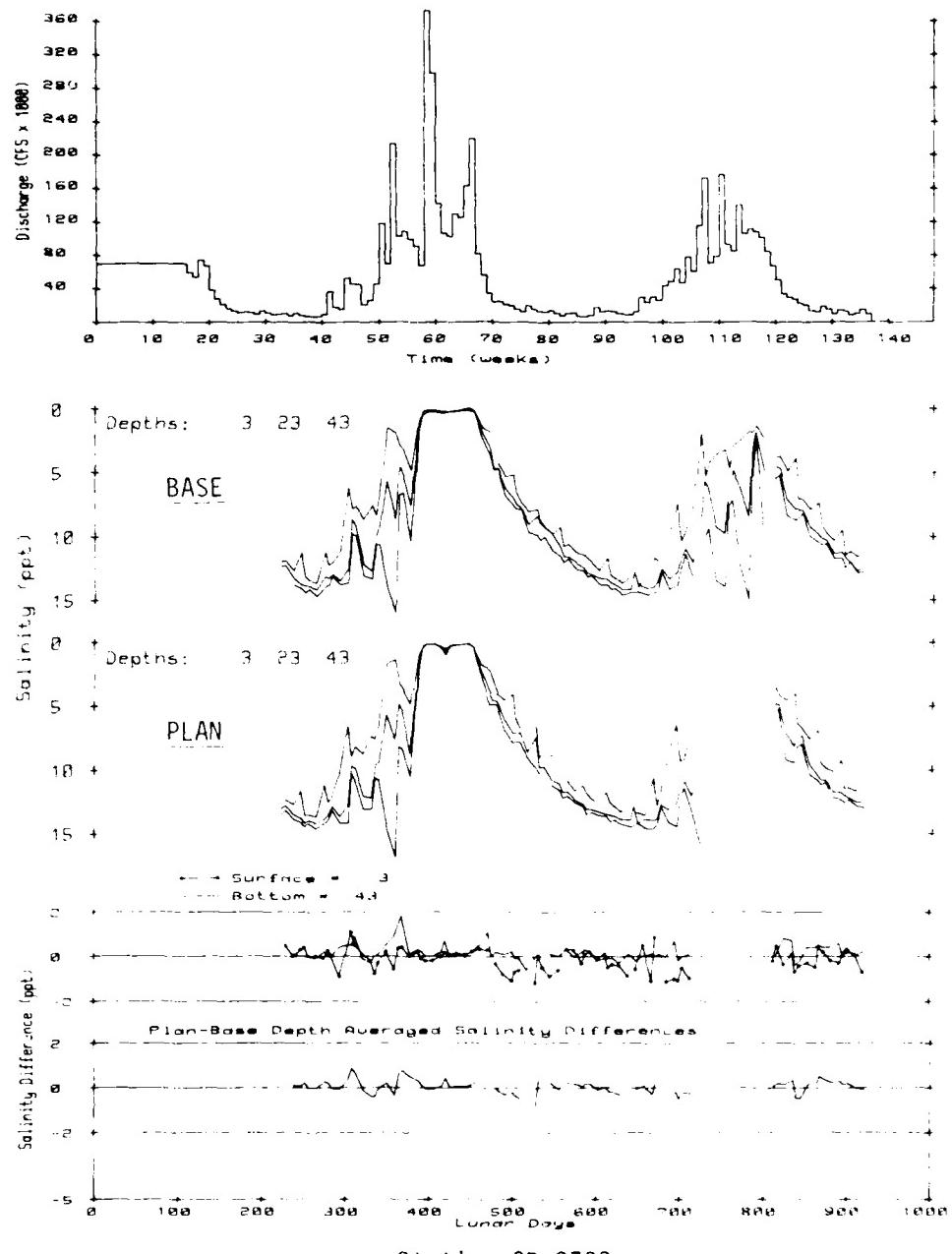
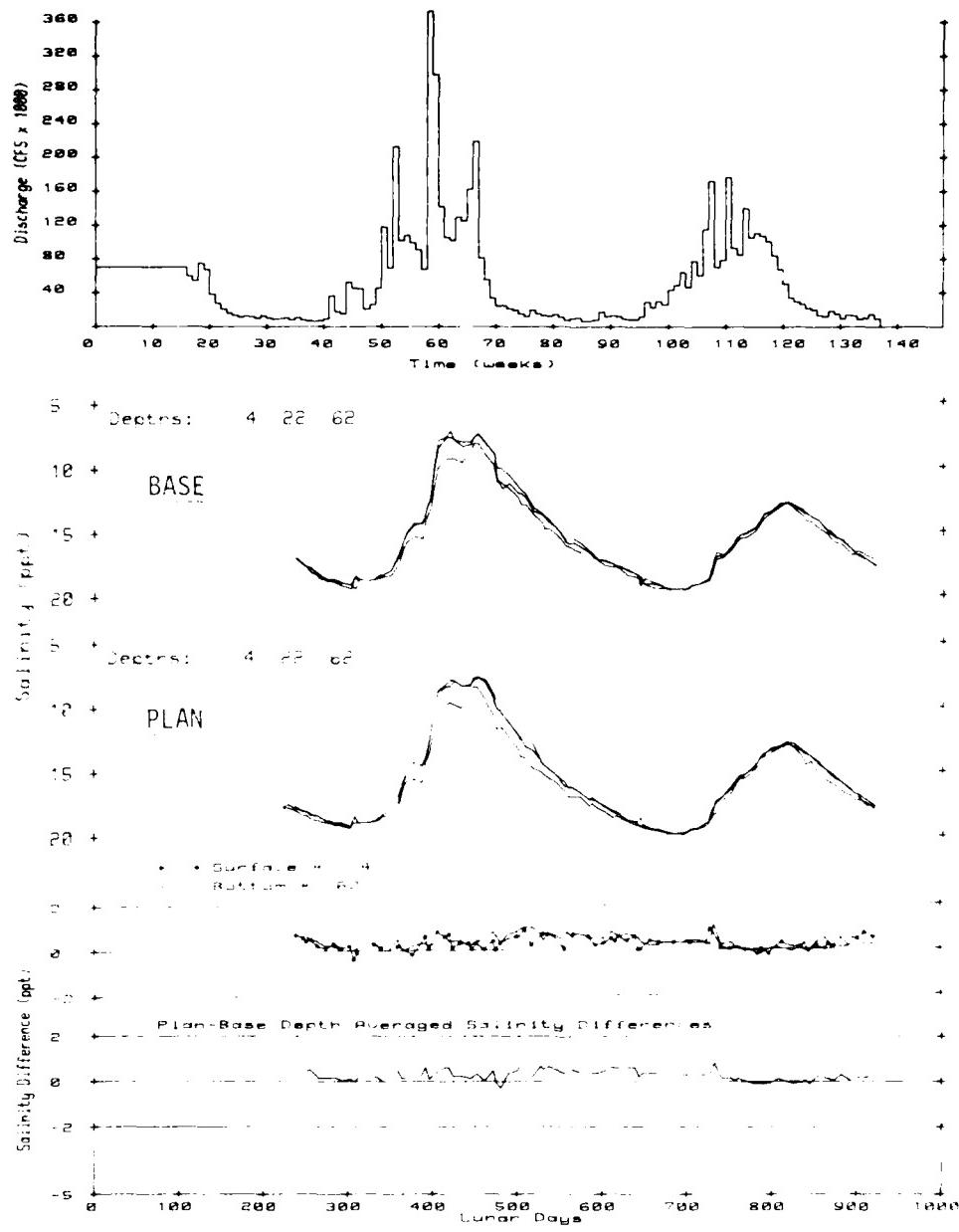


PLATE 160



Station CG 2101

PLATE 161

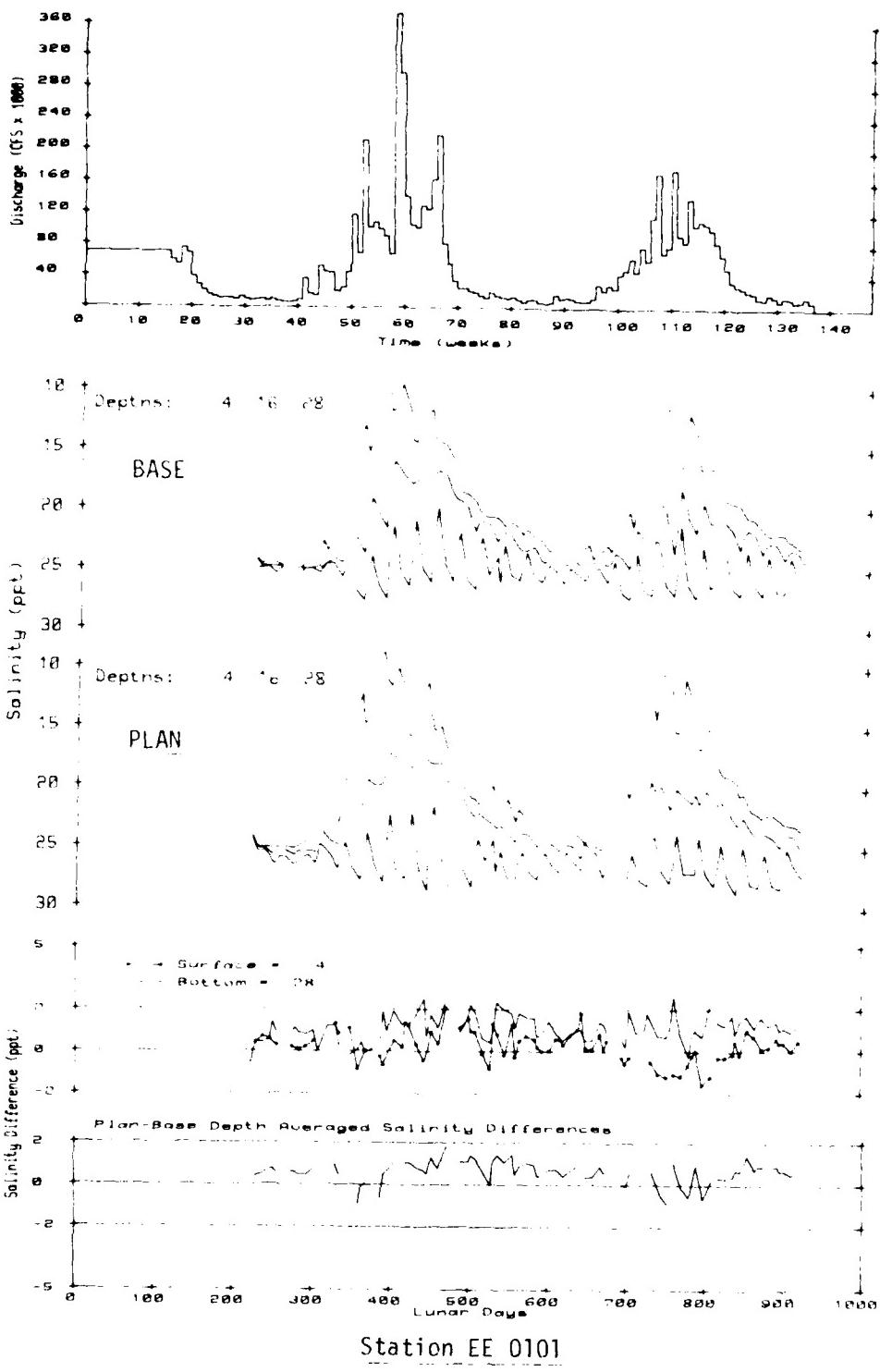
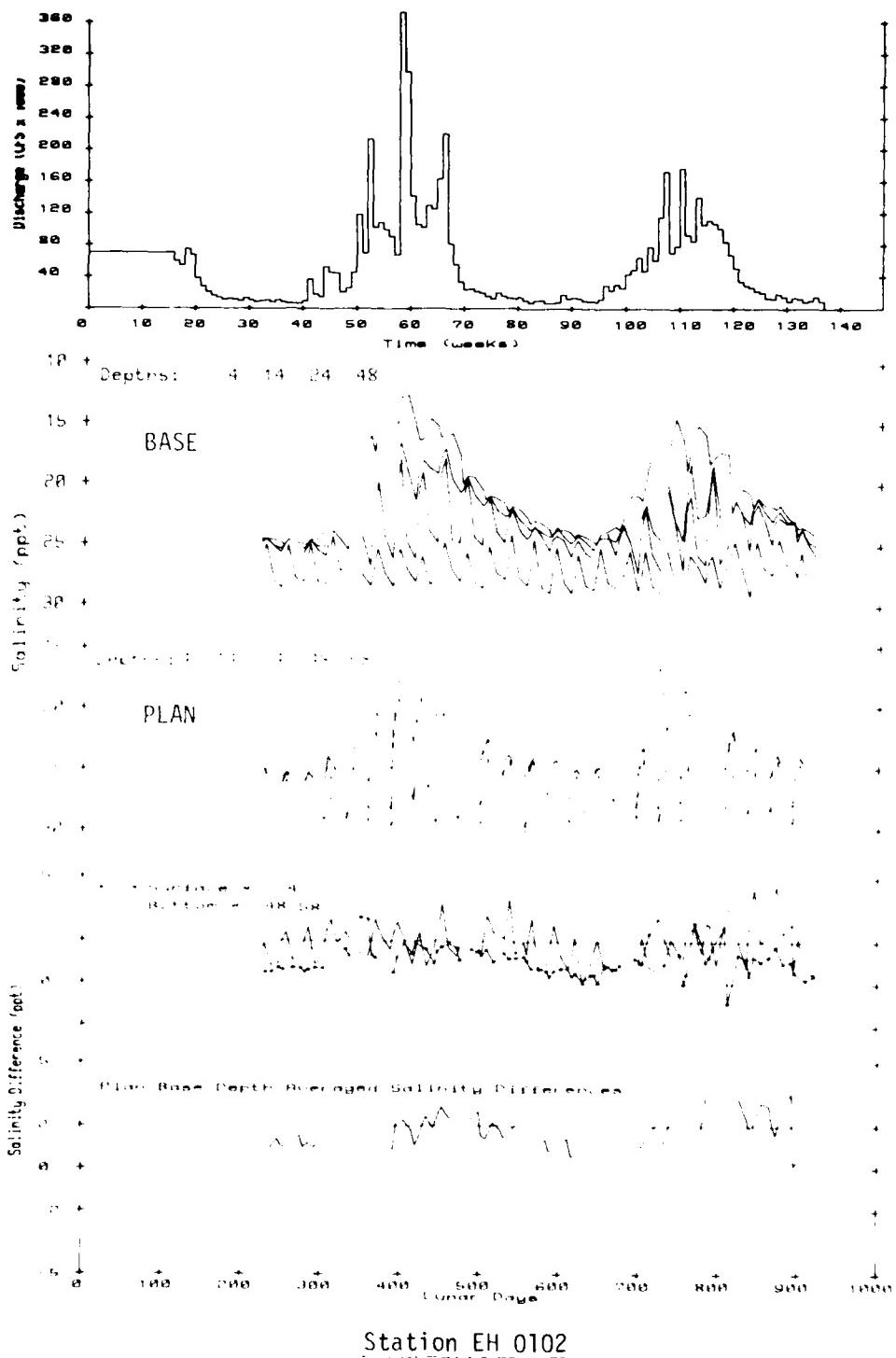


PLATE 162



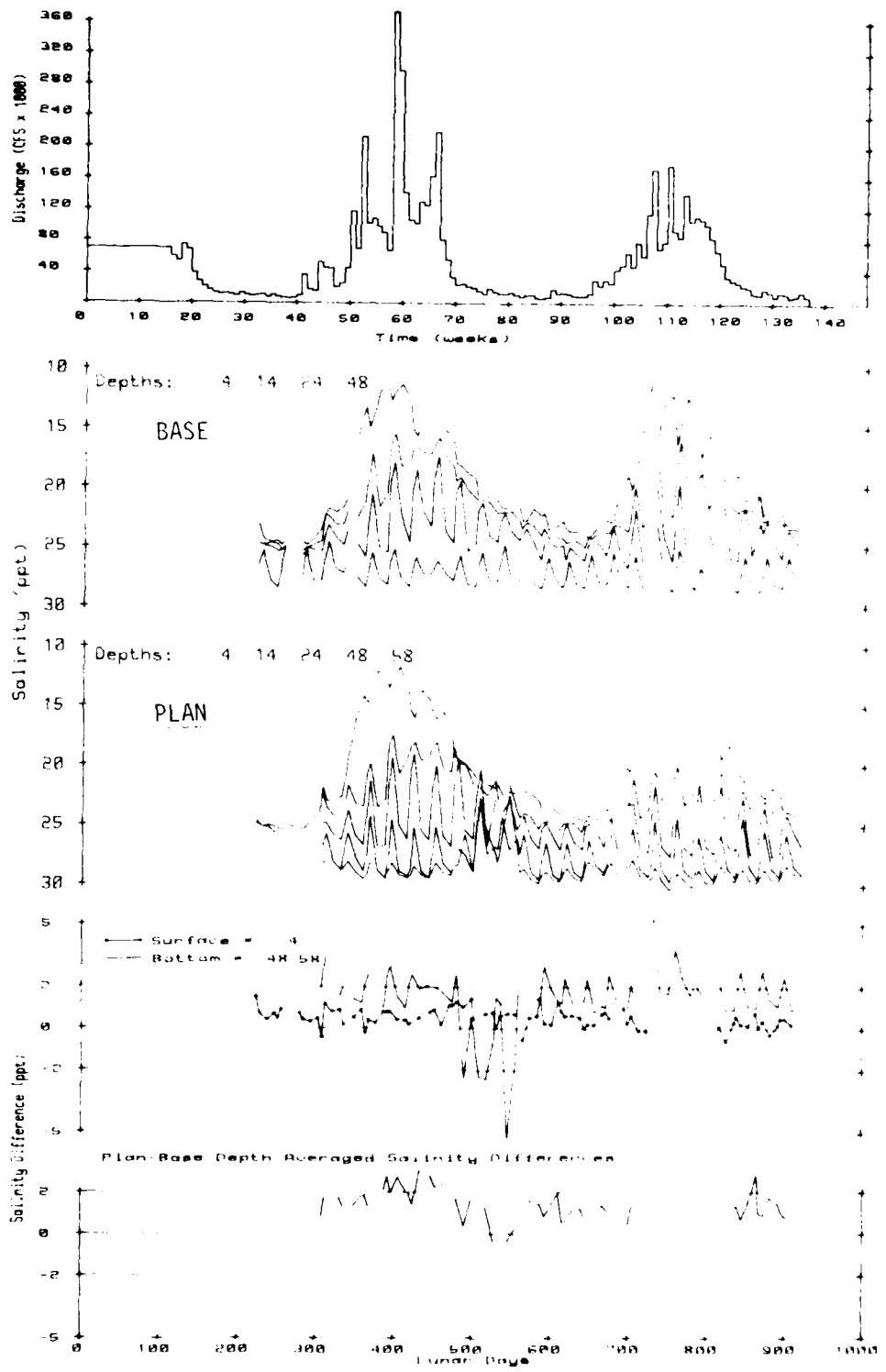
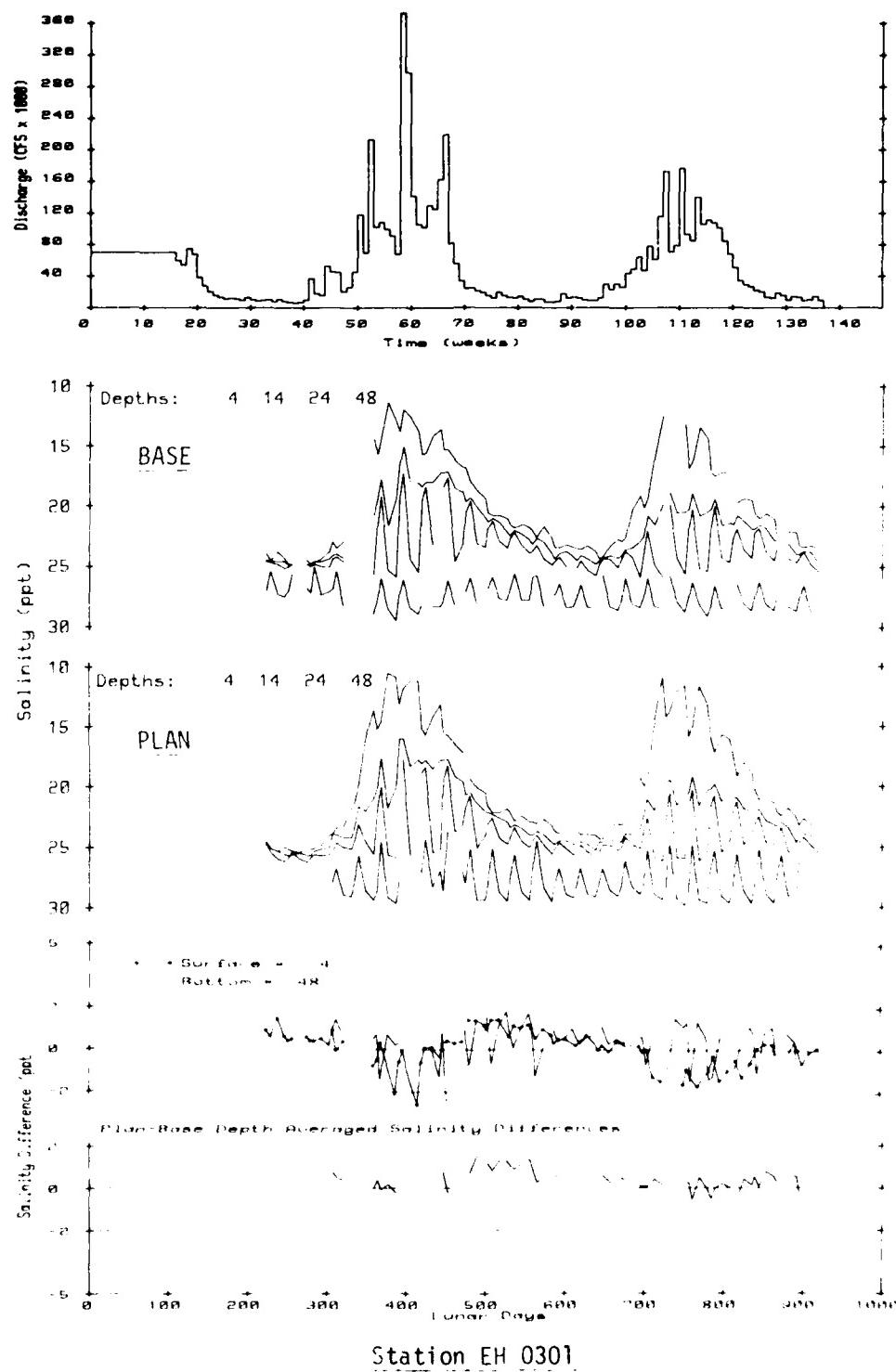


PLATE 164



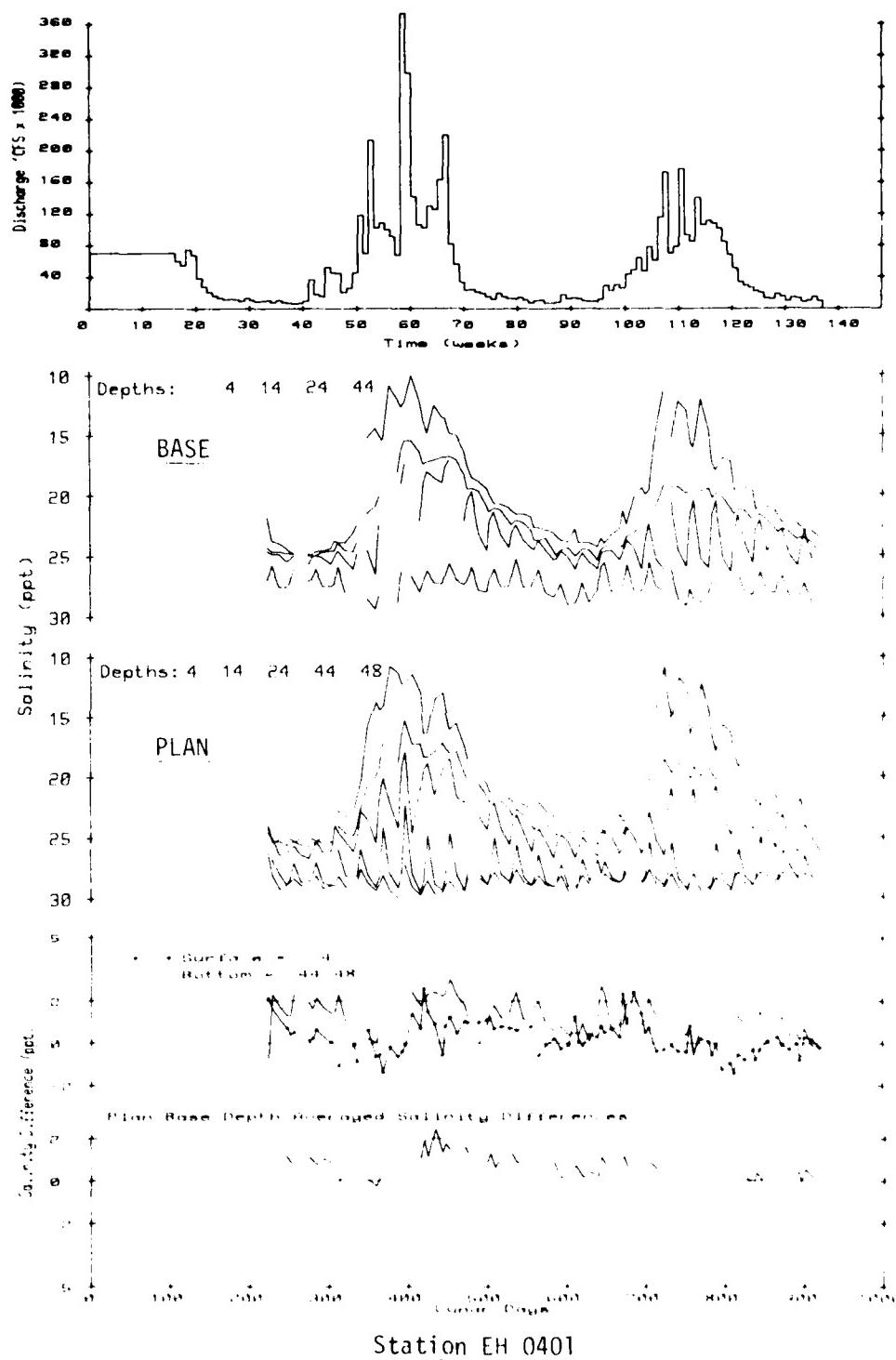


PLATE 166

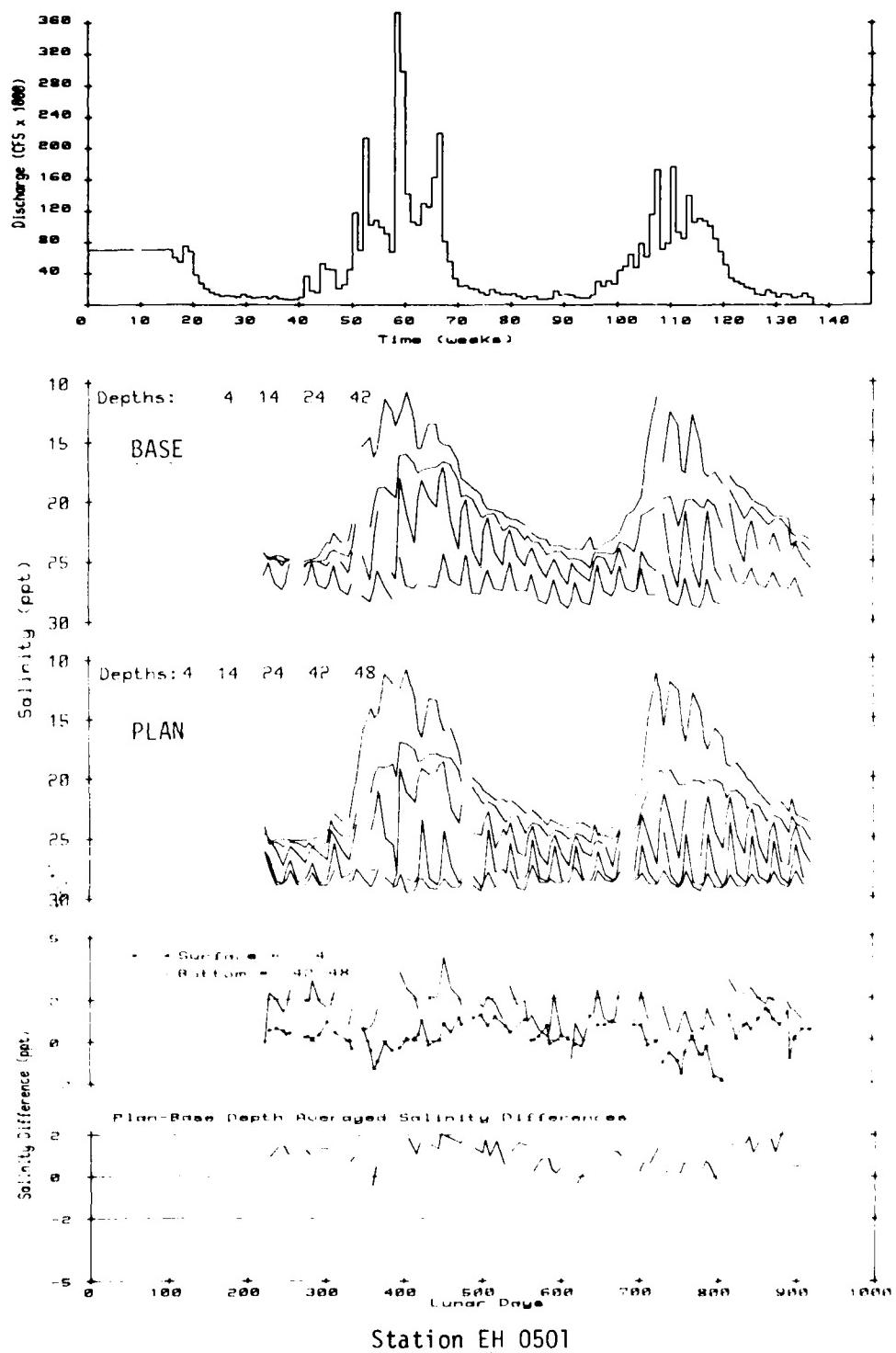
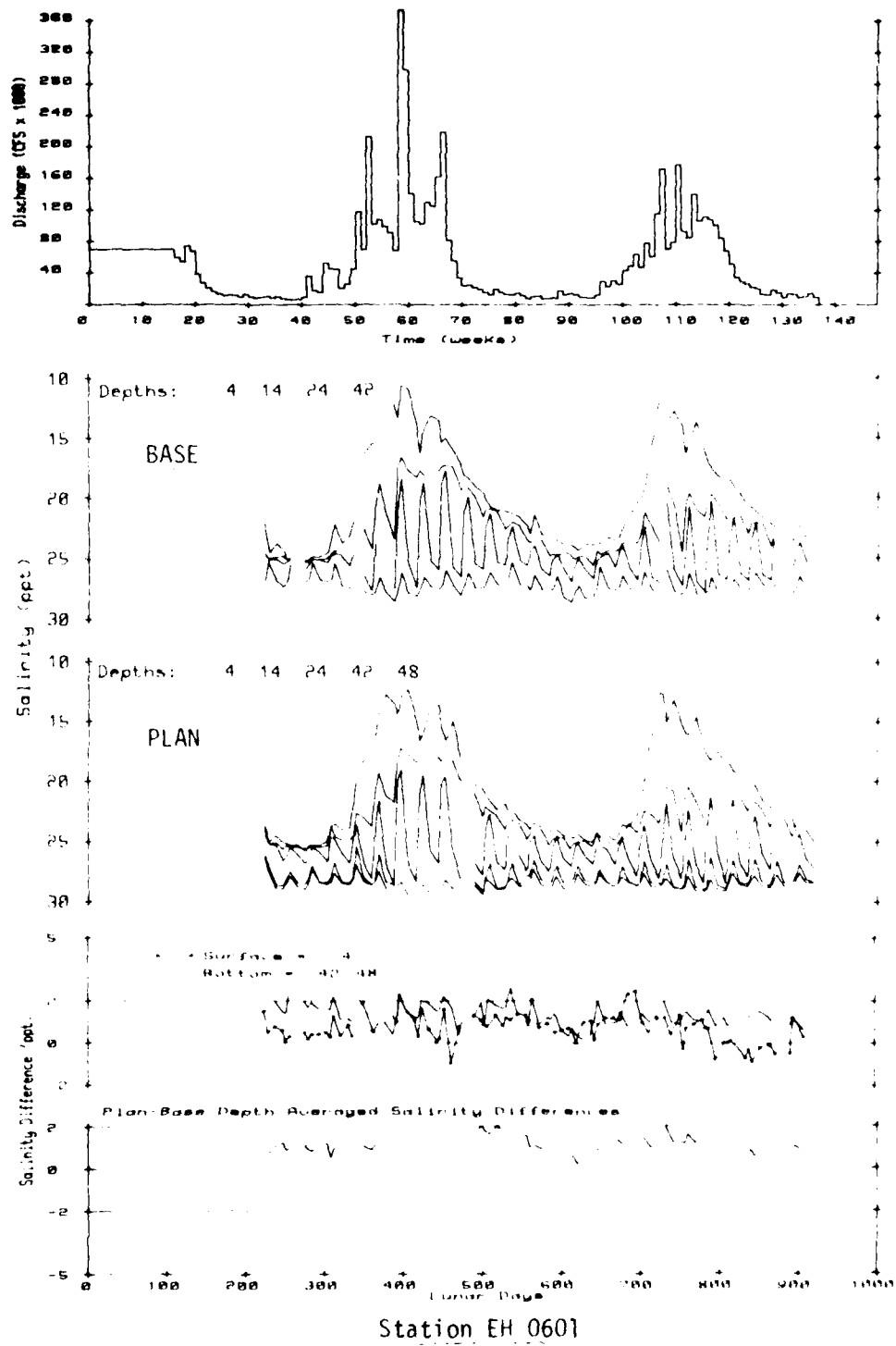


PLATE 167



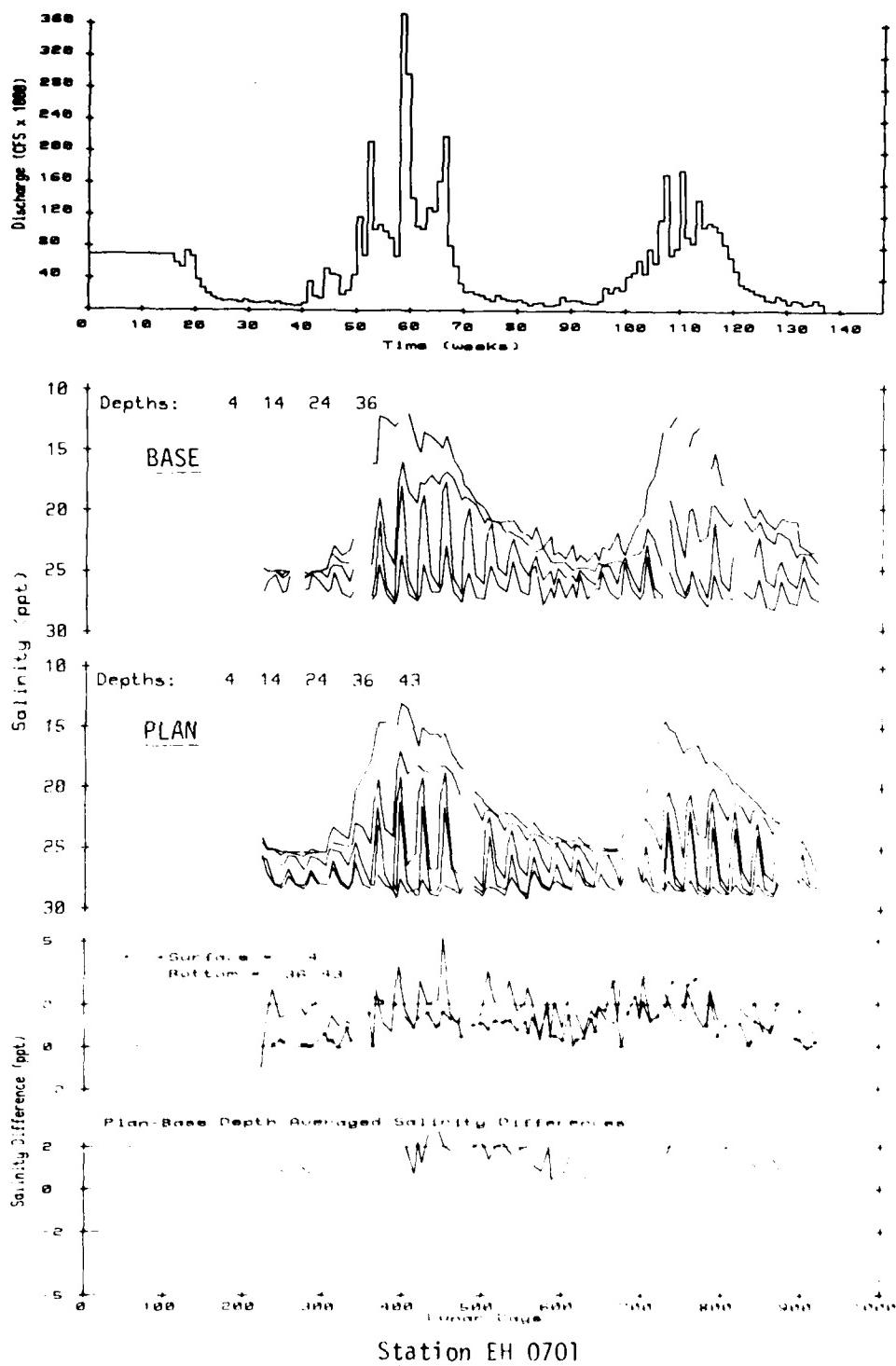


PLATE 169

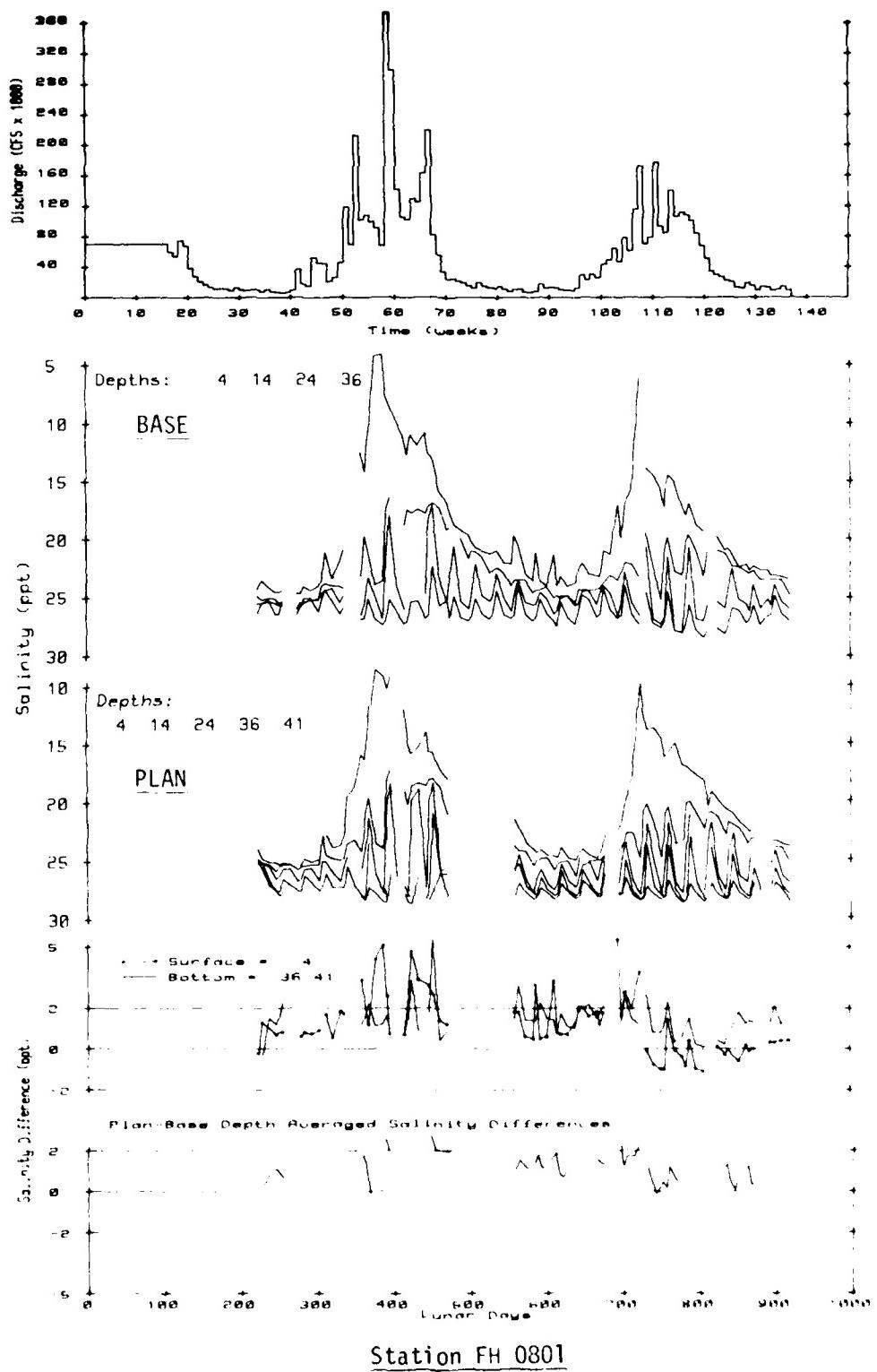
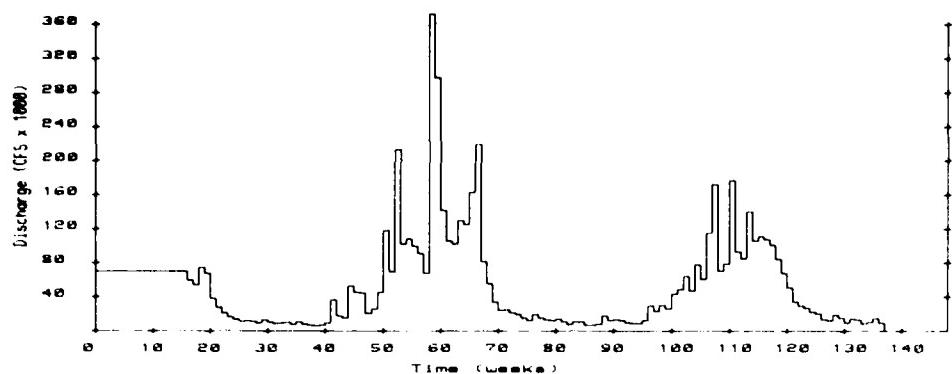


PLATE 170



Depth: 4 14 24 36

BASE

PLAN

FRONT

REAR

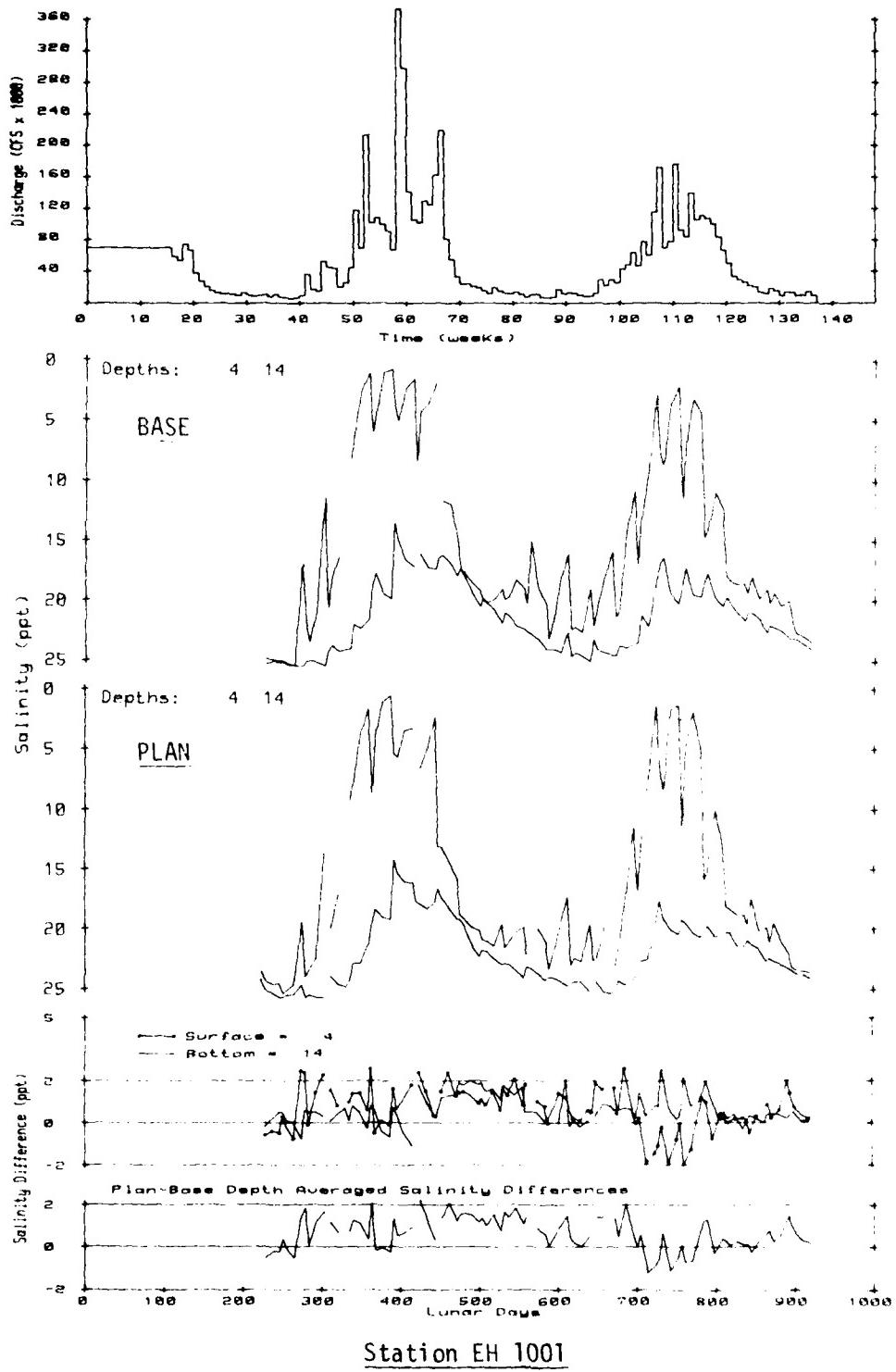
UPPER

MIDDLE

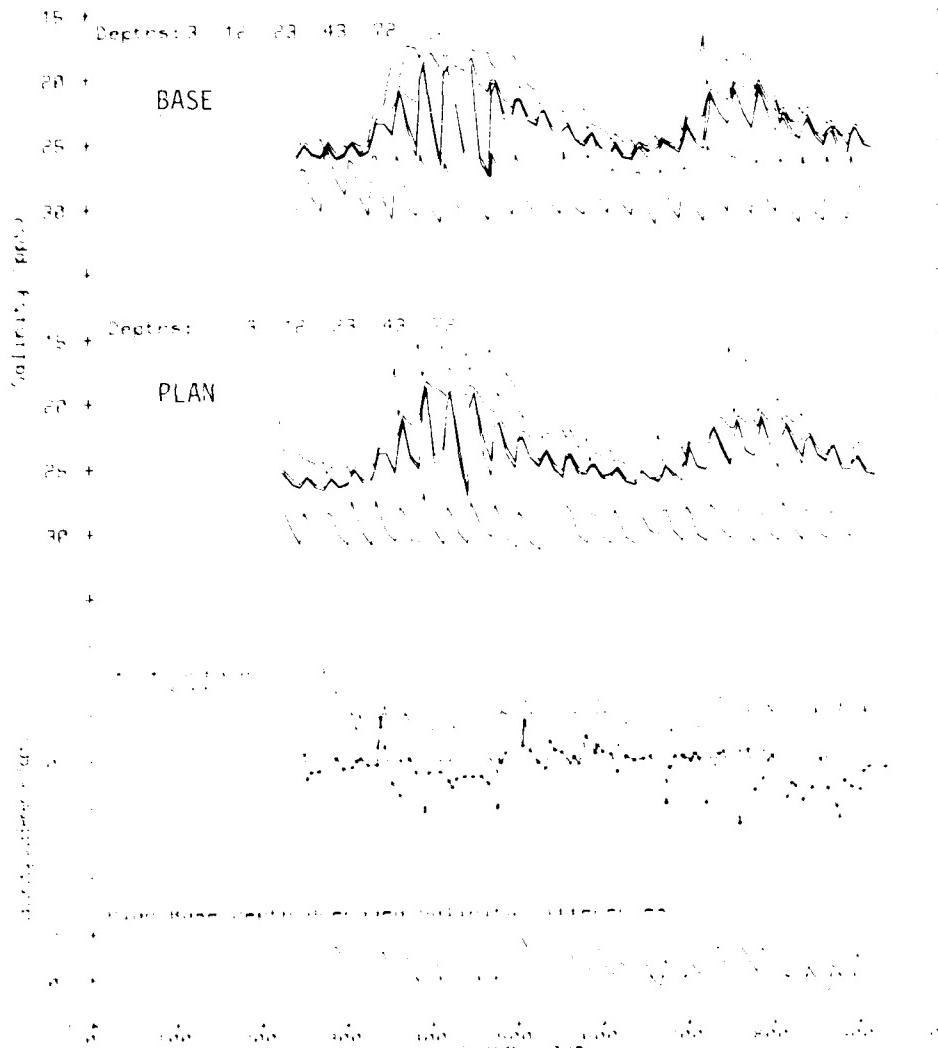
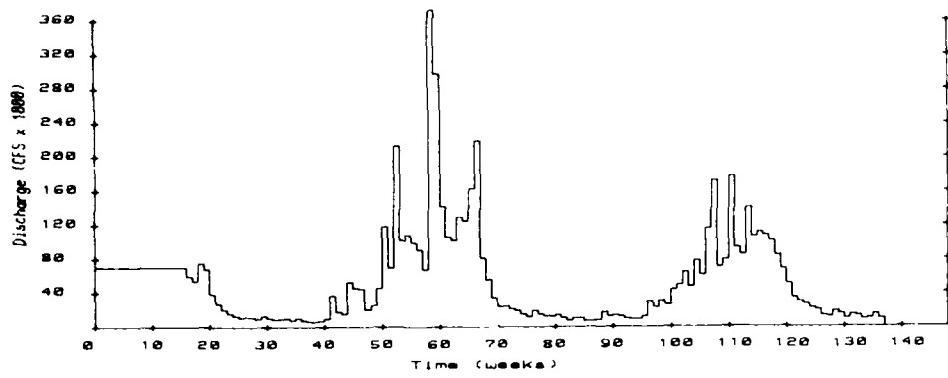
LOWER

Station EH 0901

PLATE 171



Station EH 1001



Station JG 0103

PLATE 173

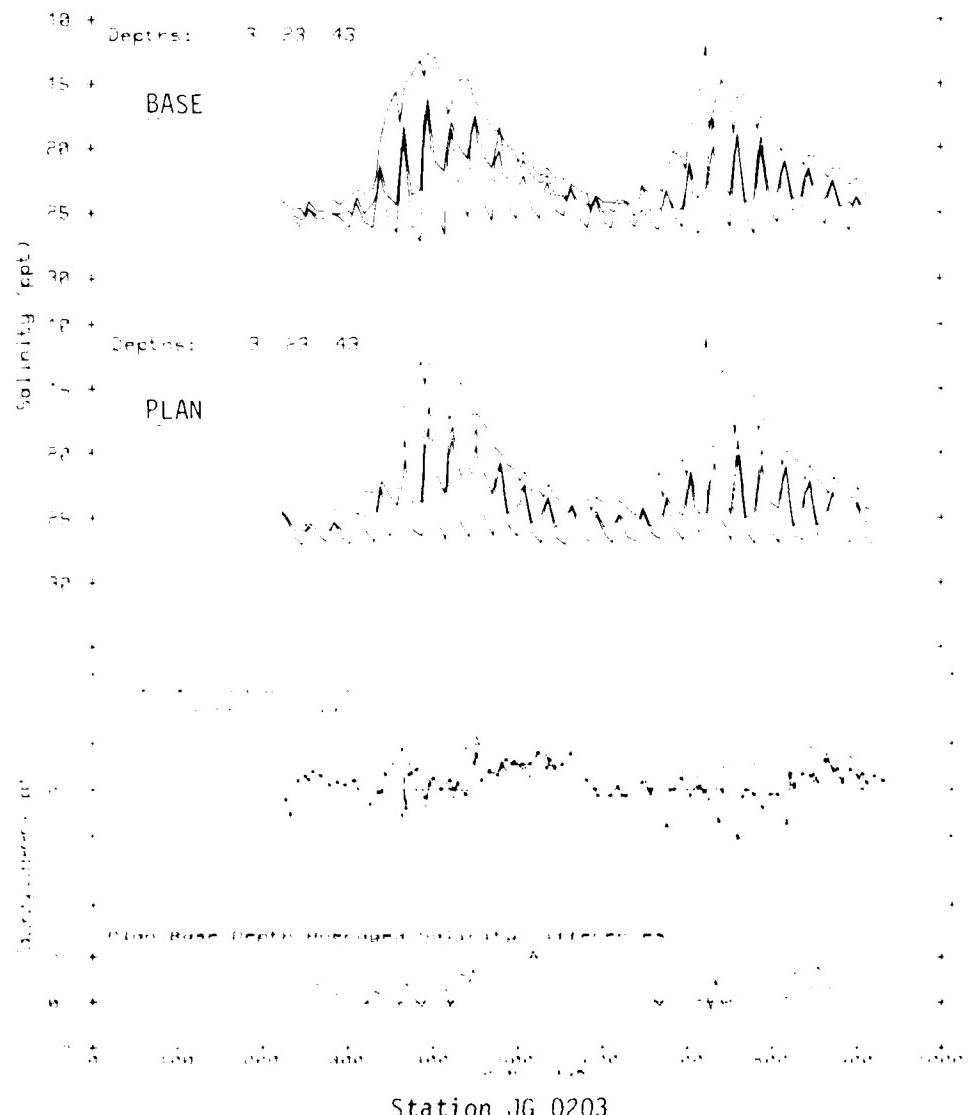
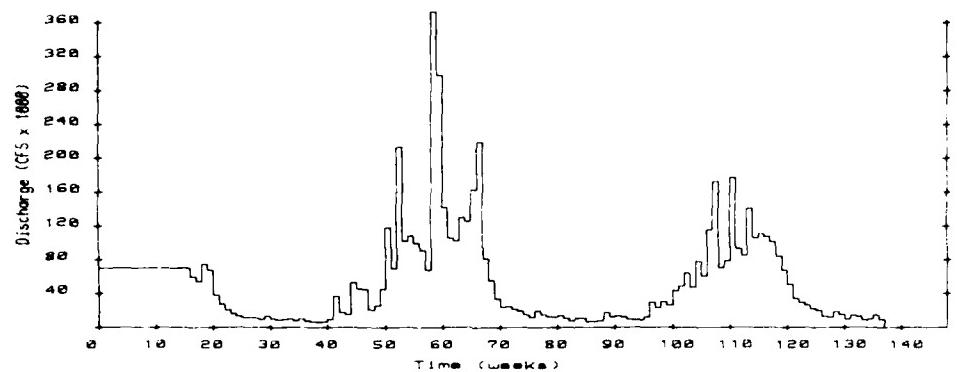
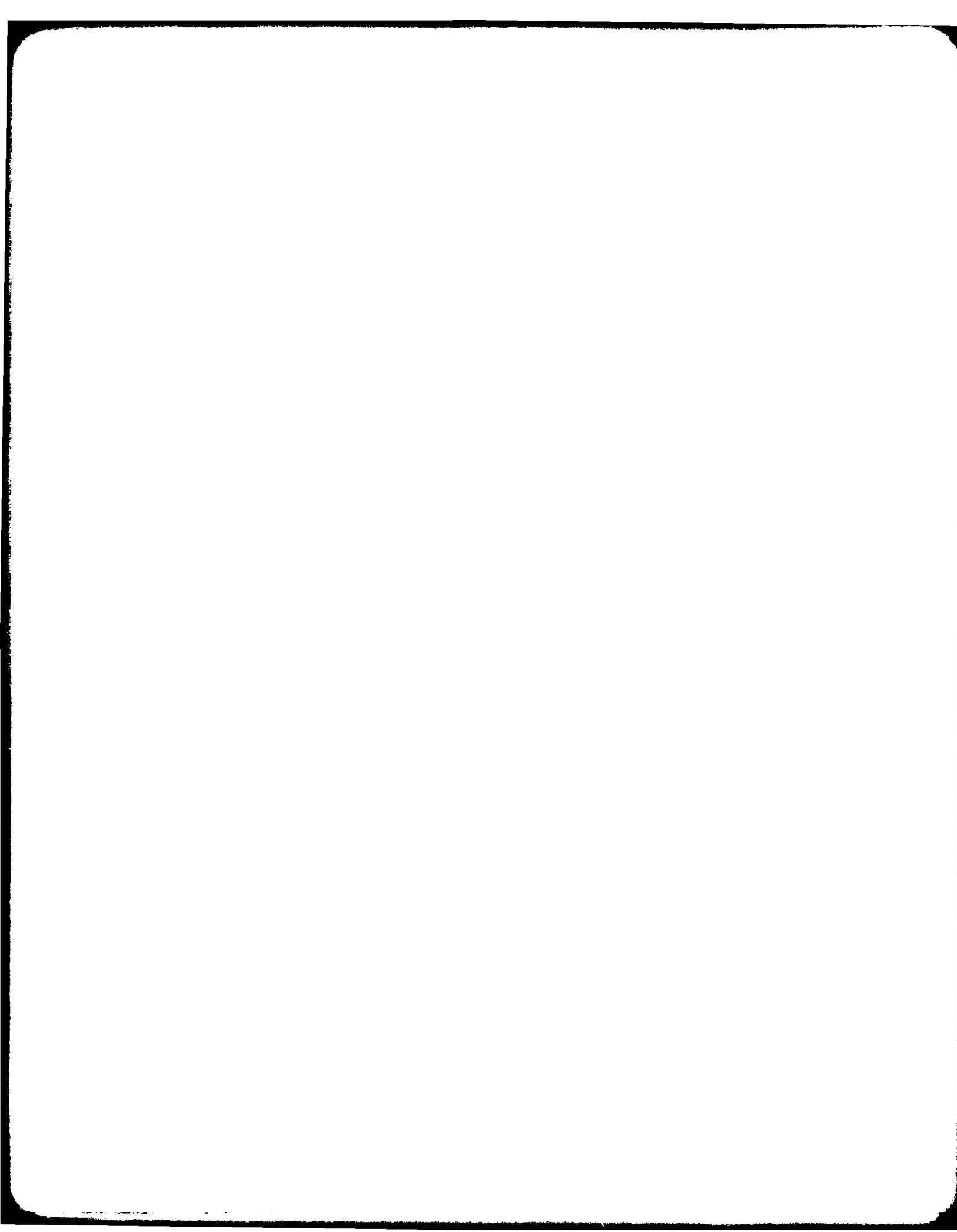
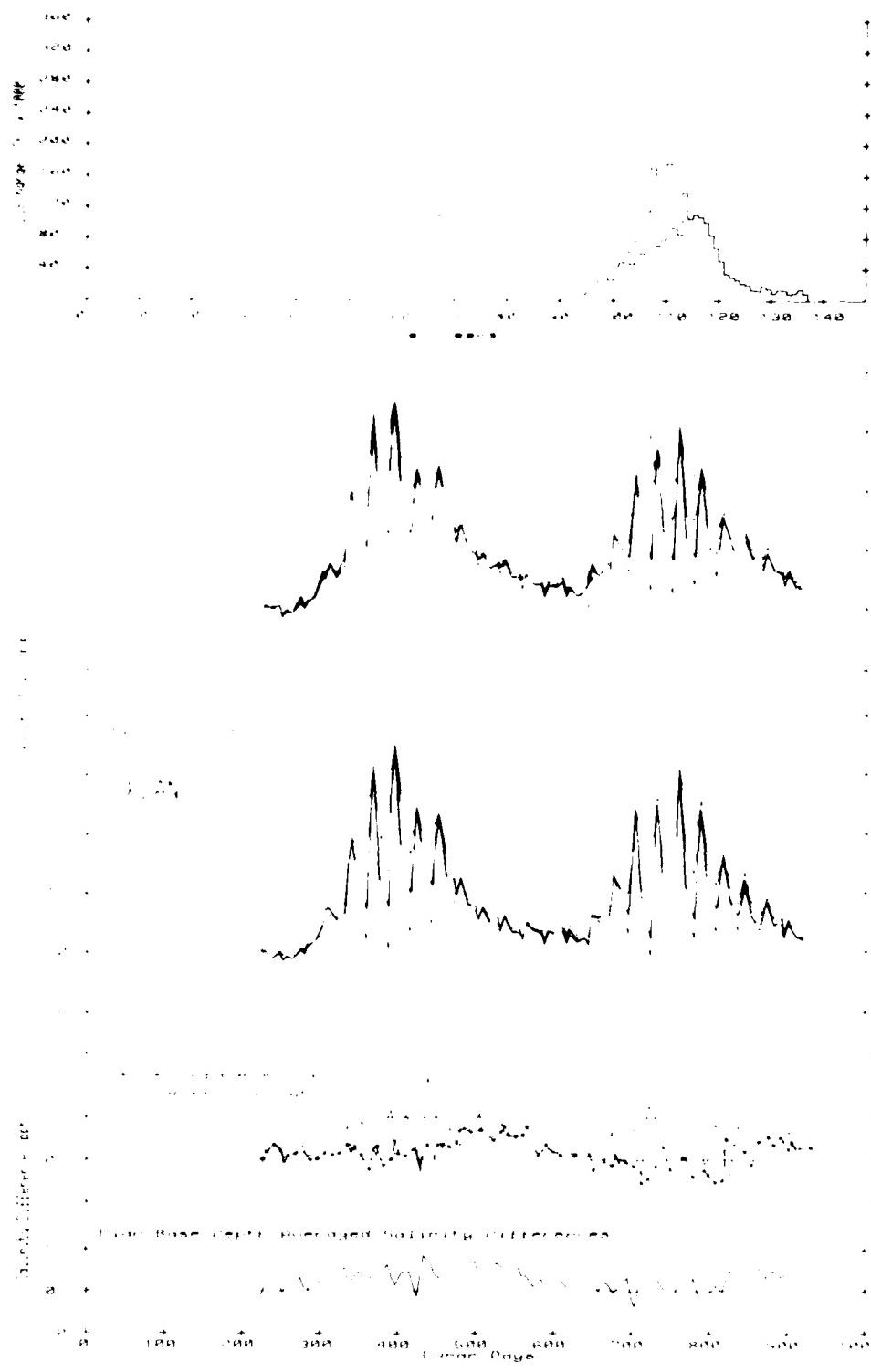


PLATE 174

Station JG 0203

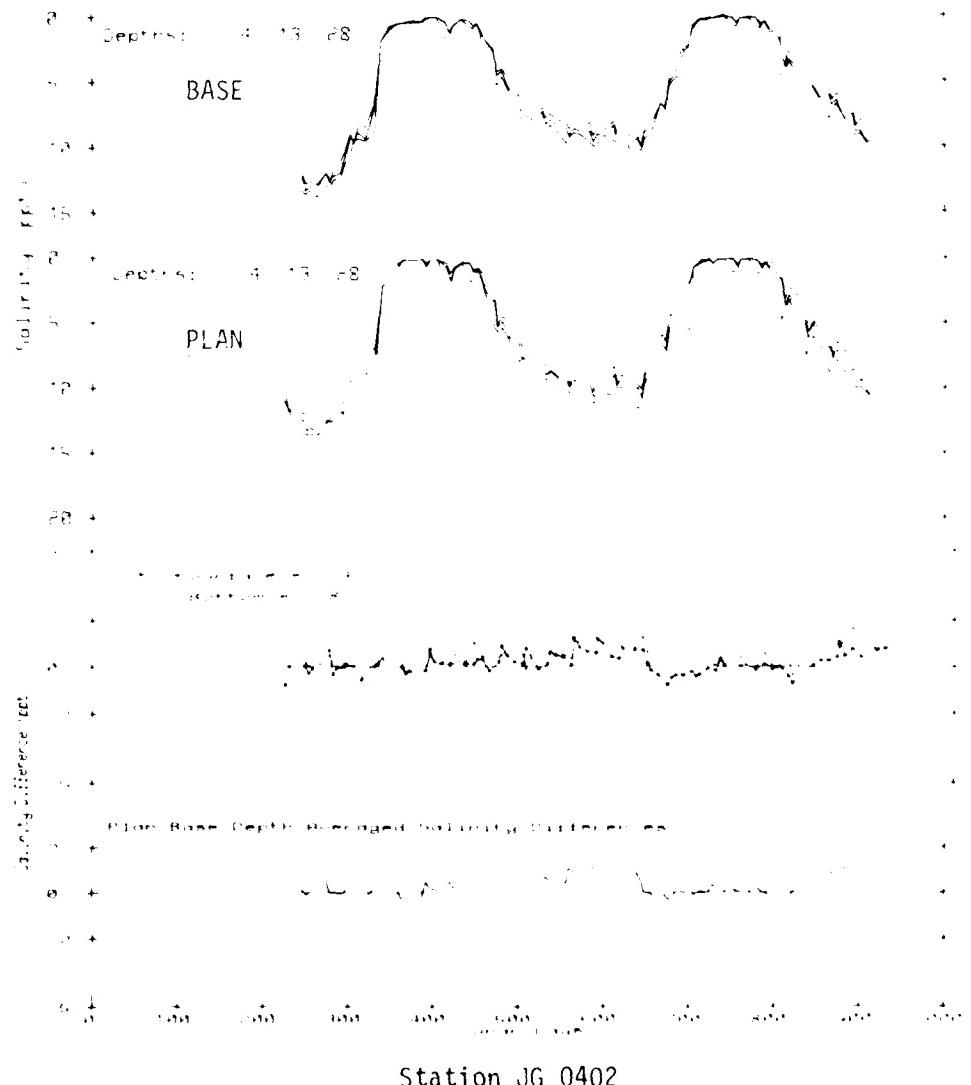
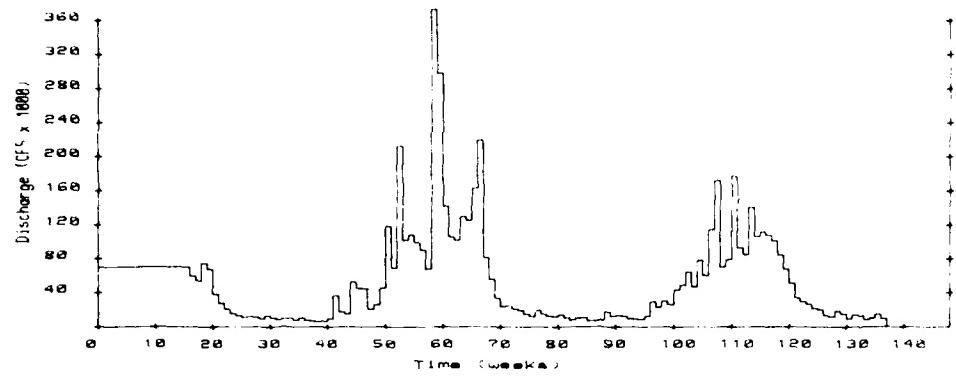




Station JG 0302

PLATE 175

PRECEDING PAGE BLANK-NOT FILMED



Station JG 0402

PLATE 176

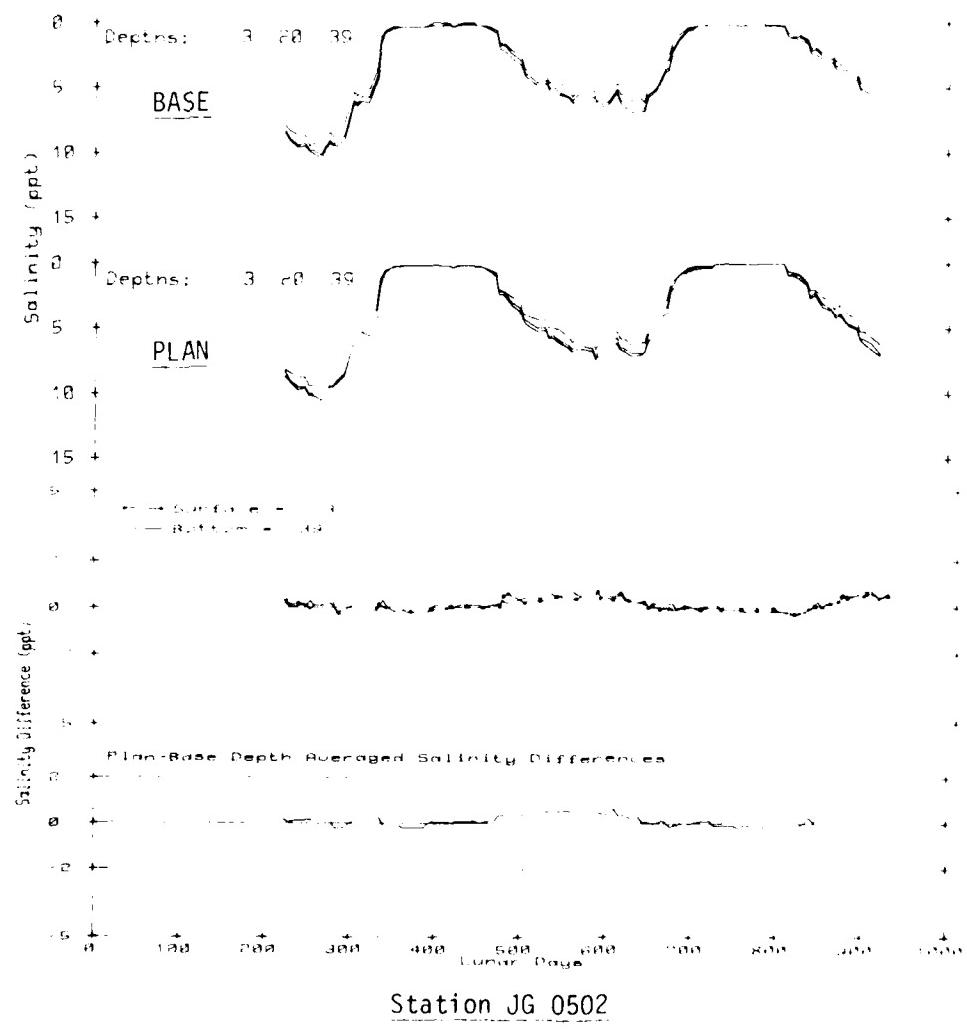
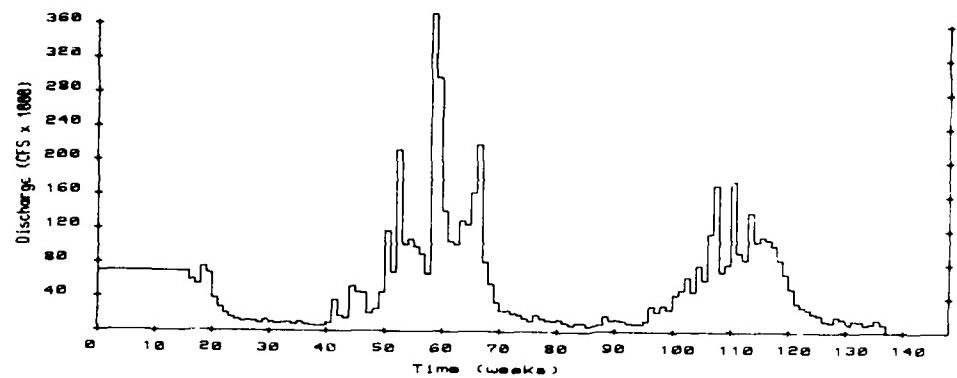


PLATE 177

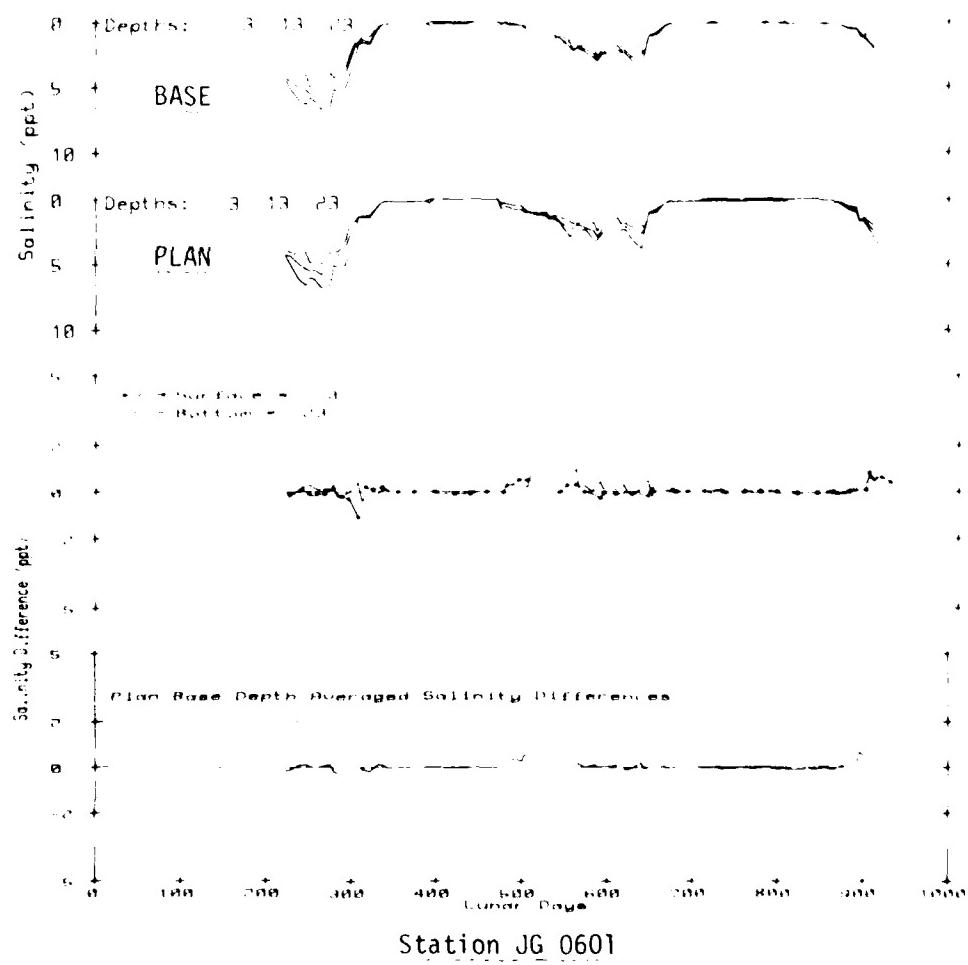
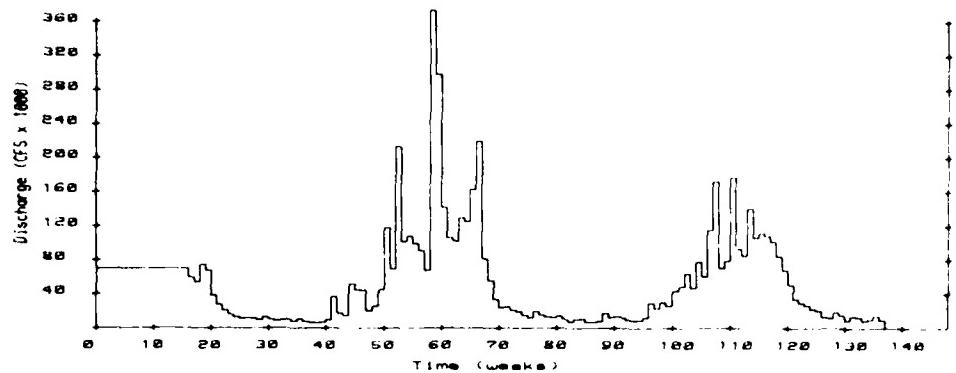
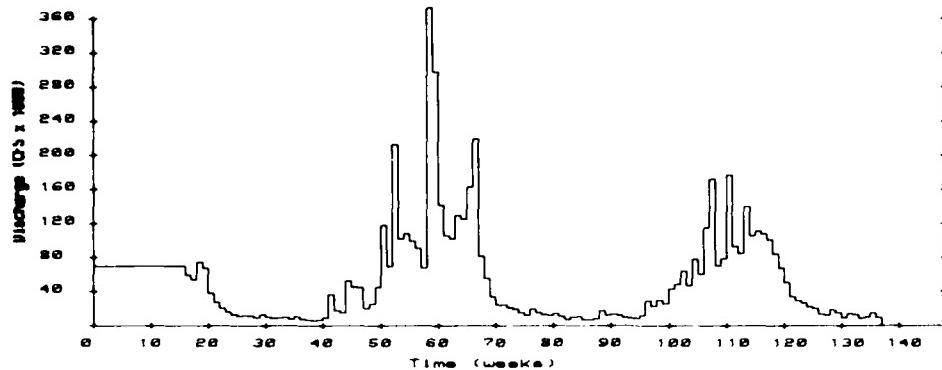


PLATE 178



15 + Depths: 4 12 28

20 + BASE

25 +

30 +

15 + Depths: 4 12 28

20 + PLAN

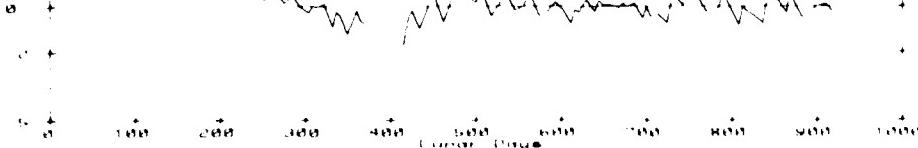
25 +

30 +

• Depth = 4
• Position = 4

Salinity Difference (ppt)

Plan-Base Depth-Averaged Salinity Difference



Station JN 0101

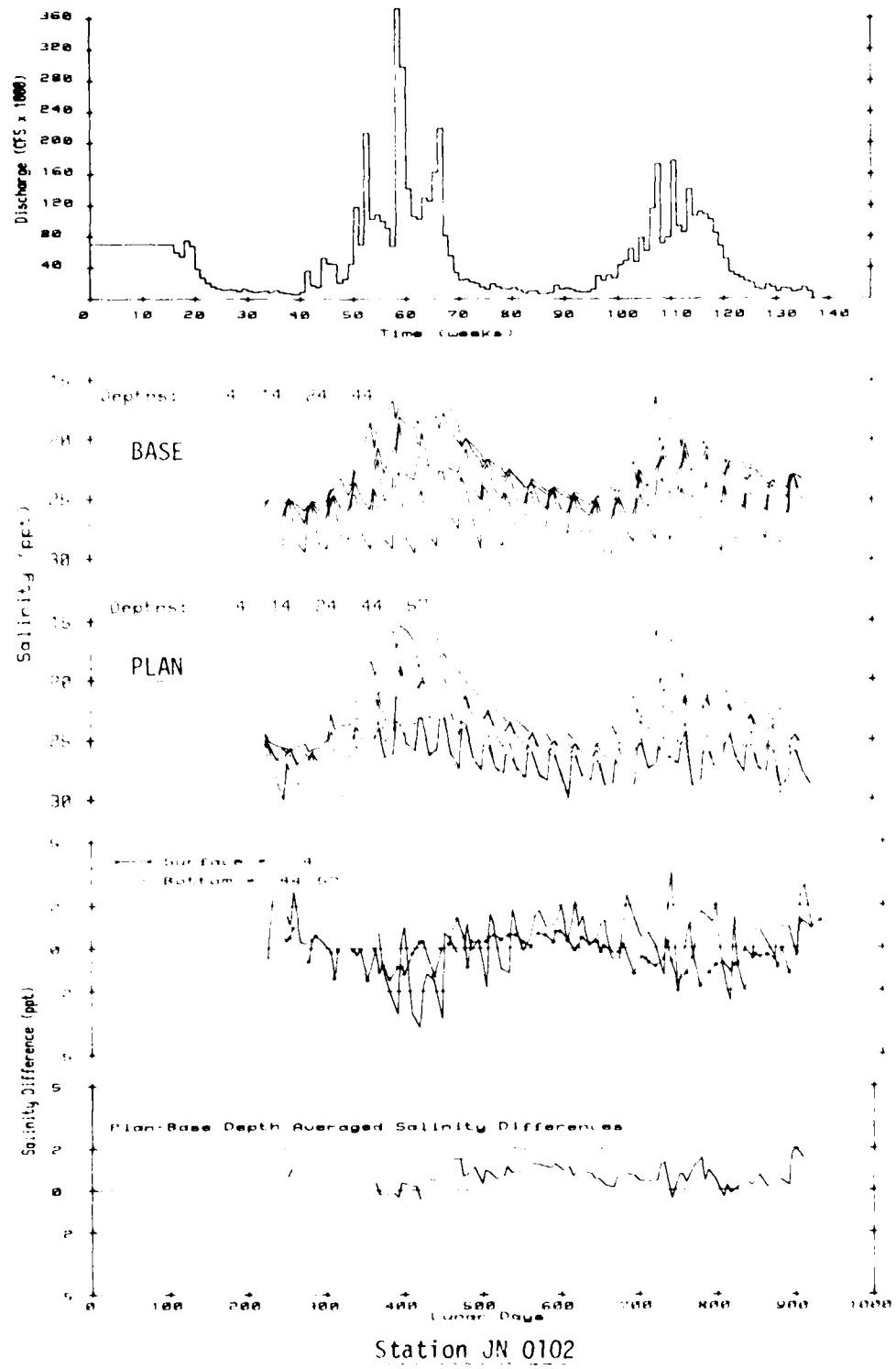
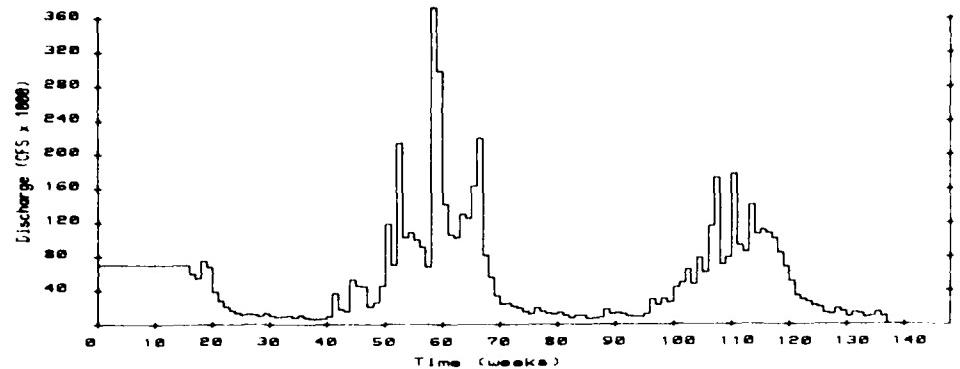


PLATE 180



15 + Depth: 4 14 24 34 58

20 + BASE

25 +

30 + Depth: 4 14 24 34 58

35 + PLAN

40 +

45 +

50 +

55 +

60 +

65 +

70 +

75 +

80 +

85 +

90 +

95 +

100 +

105 +

110 +

115 +

120 +

125 +

130 +

135 +

140 +

145 +

150 +

155 +

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210 +

215 +

220 +

225 +

230 +

235 +

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245 +

250 +

255 +

260 +

265 +

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275 +

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370 +

375 +

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410 +

415 +

420 +

425 +

430 +

435 +

440 +

445 +

450 +

455 +

460 +

465 +

470 +

475 +

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515 +

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545 +

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555 +

560 +

565 +

570 +

575 +

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710 +

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730 +

735 +

740 +

745 +

750 +

755 +

760 +

765 +

770 +

775 +

780 +

785 +

790 +

795 +

800 +

805 +

810 +

815 +

820 +

825 +

830 +

835 +

840 +

845 +

850 +

855 +

860 +

865 +

870 +

875 +

880 +

885 +

890 +

895 +

900 +

905 +

910 +

915 +

920 +

925 +

930 +

935 +

940 +

945 +

950 +

955 +

960 +

965 +

970 +

975 +

980 +

985 +

990 +

995 +

1000 +

1005 +

1010 +

1015 +

1020 +

1025 +

1030 +

1035 +

1040 +

1045 +

1050 +

1055 +

1060 +

1065 +

1070 +

1075 +

1080 +

1085 +

1090 +

1095 +

1100 +

1105 +

1110 +

1115 +

1120 +

1125 +

1130 +

1135 +

1140 +

1145 +

1150 +

1155 +

1160 +

1165 +

1170 +

1175 +

1180 +

1185 +

1190 +

1195 +

1200 +

1205 +

1210 +

1215 +

1220 +

1225 +

1230 +

1235 +

1240 +

1245 +

1250 +

1255 +

1260 +

1265 +

1270 +

1275 +

1280 +

1285 +

1290 +

1295 +

1300 +

1305 +

1310 +

1315 +

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1345 +

1350 +

1355 +

1360 +

1365 +

1370 +

1375 +

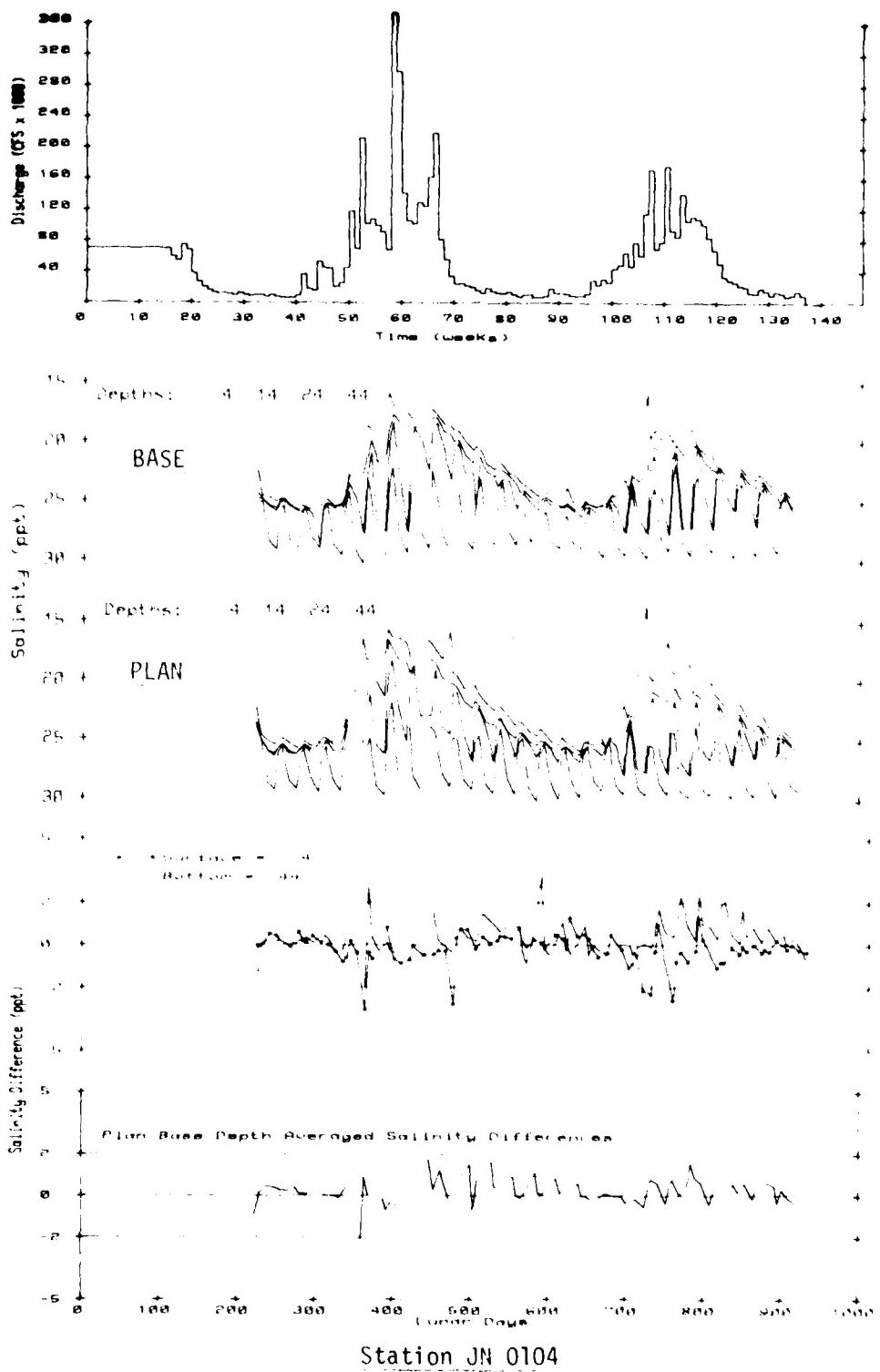
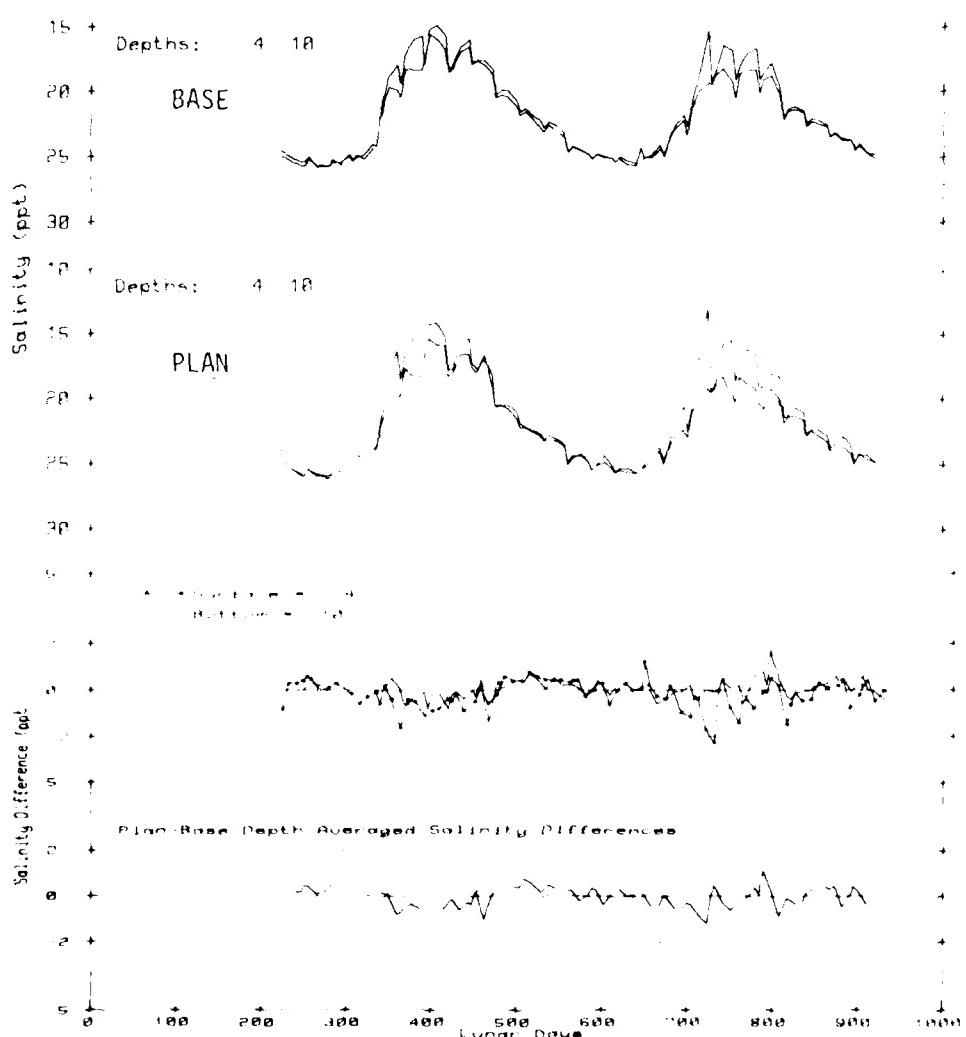
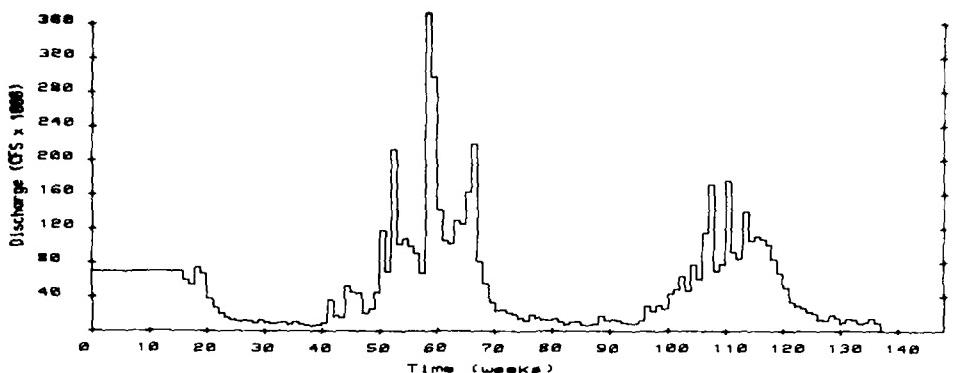


PLATE 182



Station JN 0103

PLATE 183

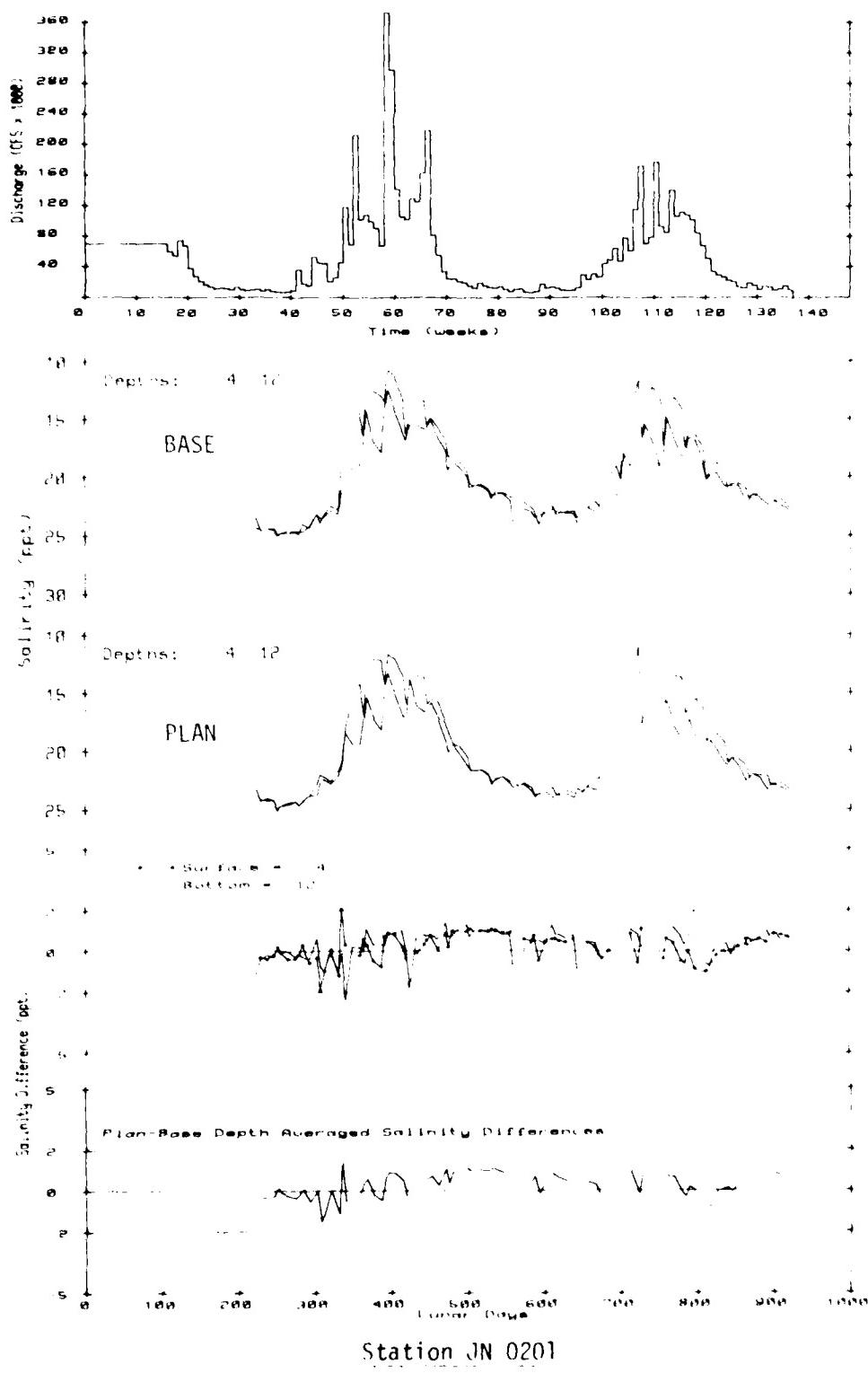
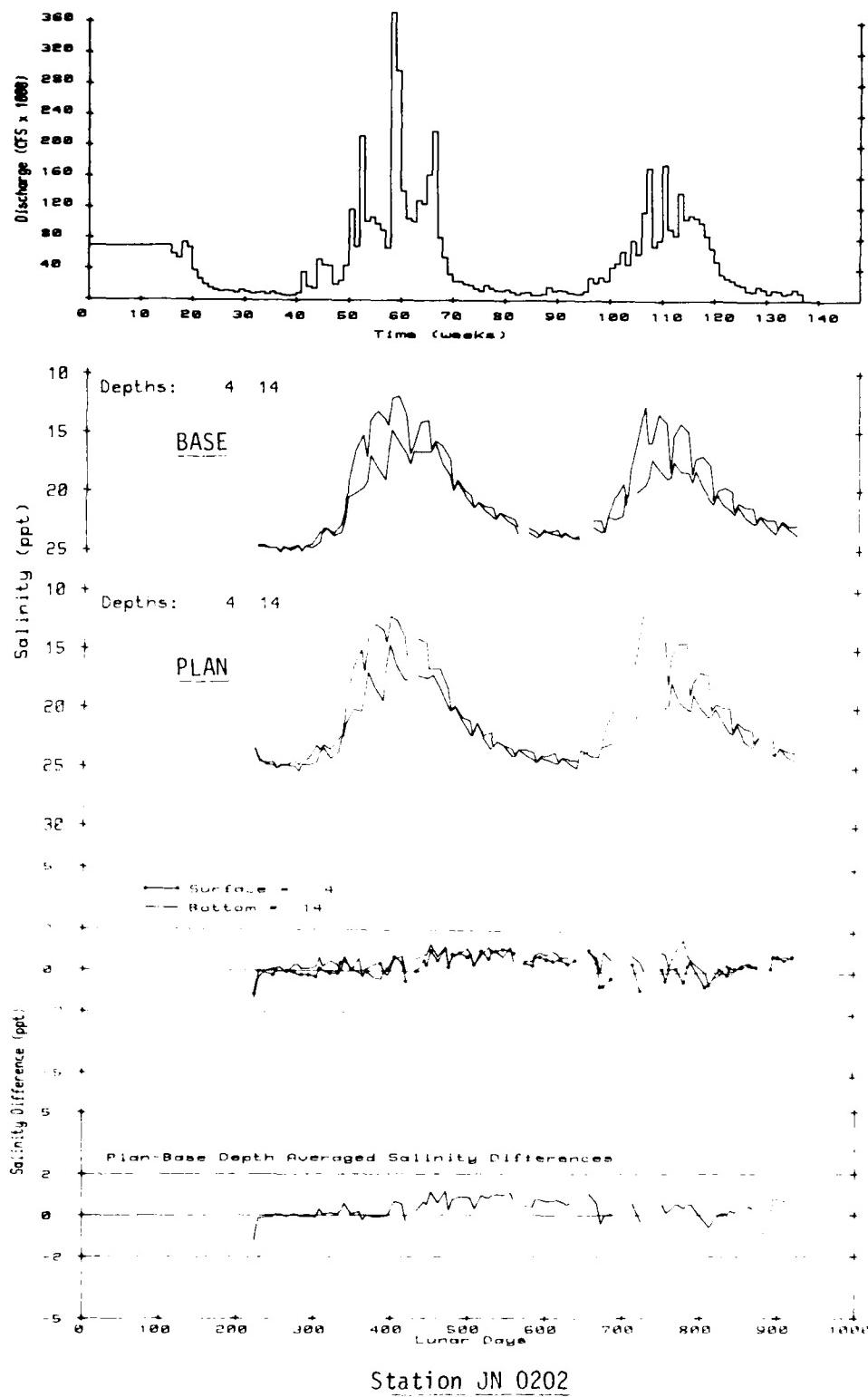


PLATE 184



Station JN 0202

PLATE 185

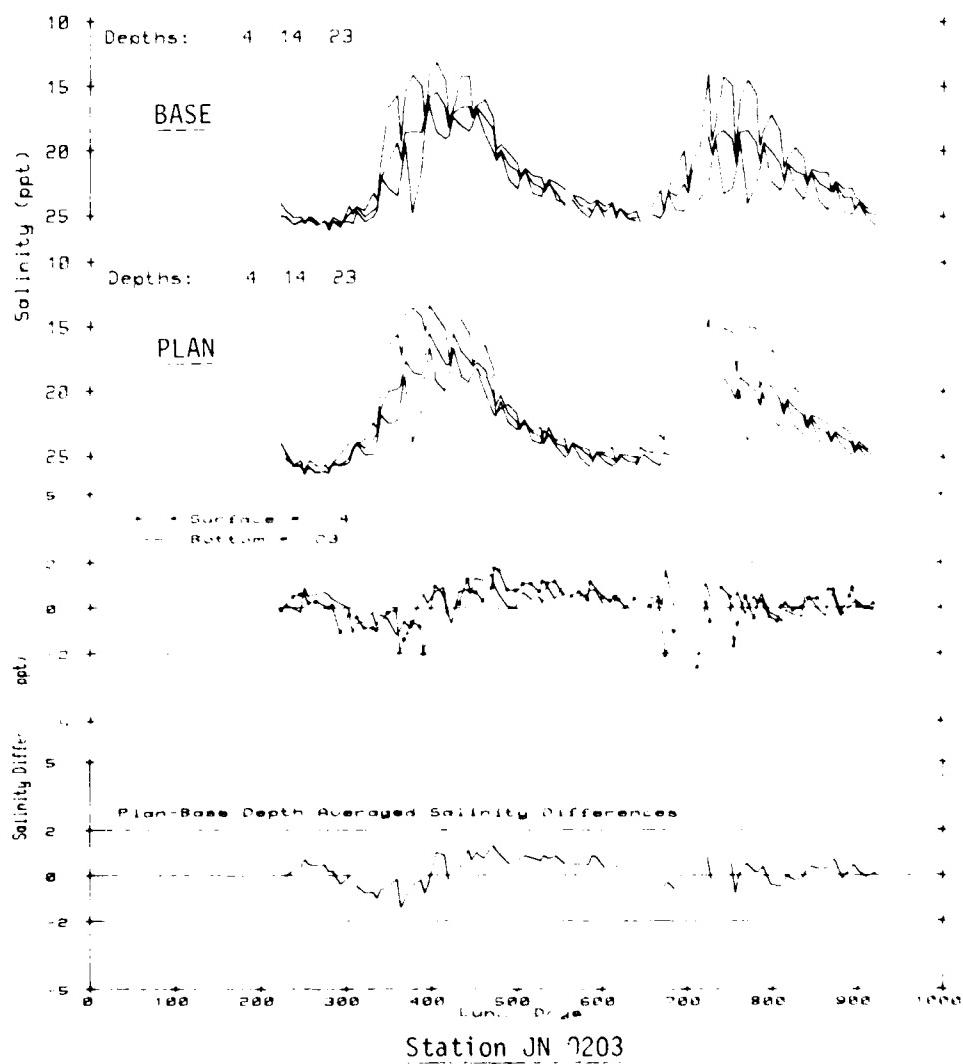
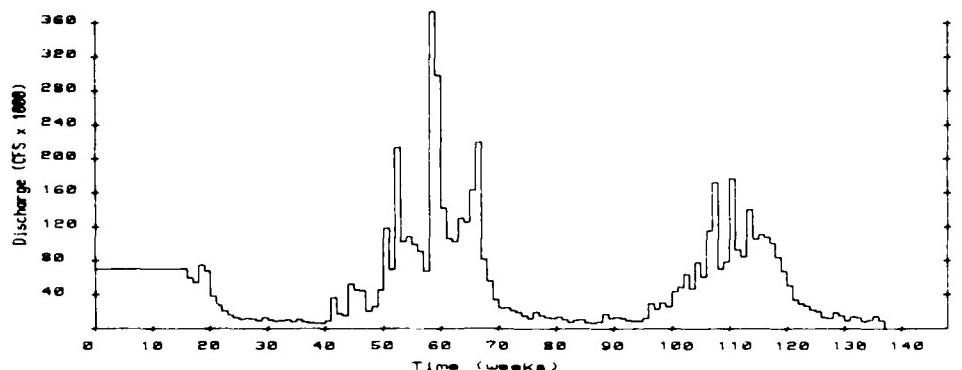


PLATE 186

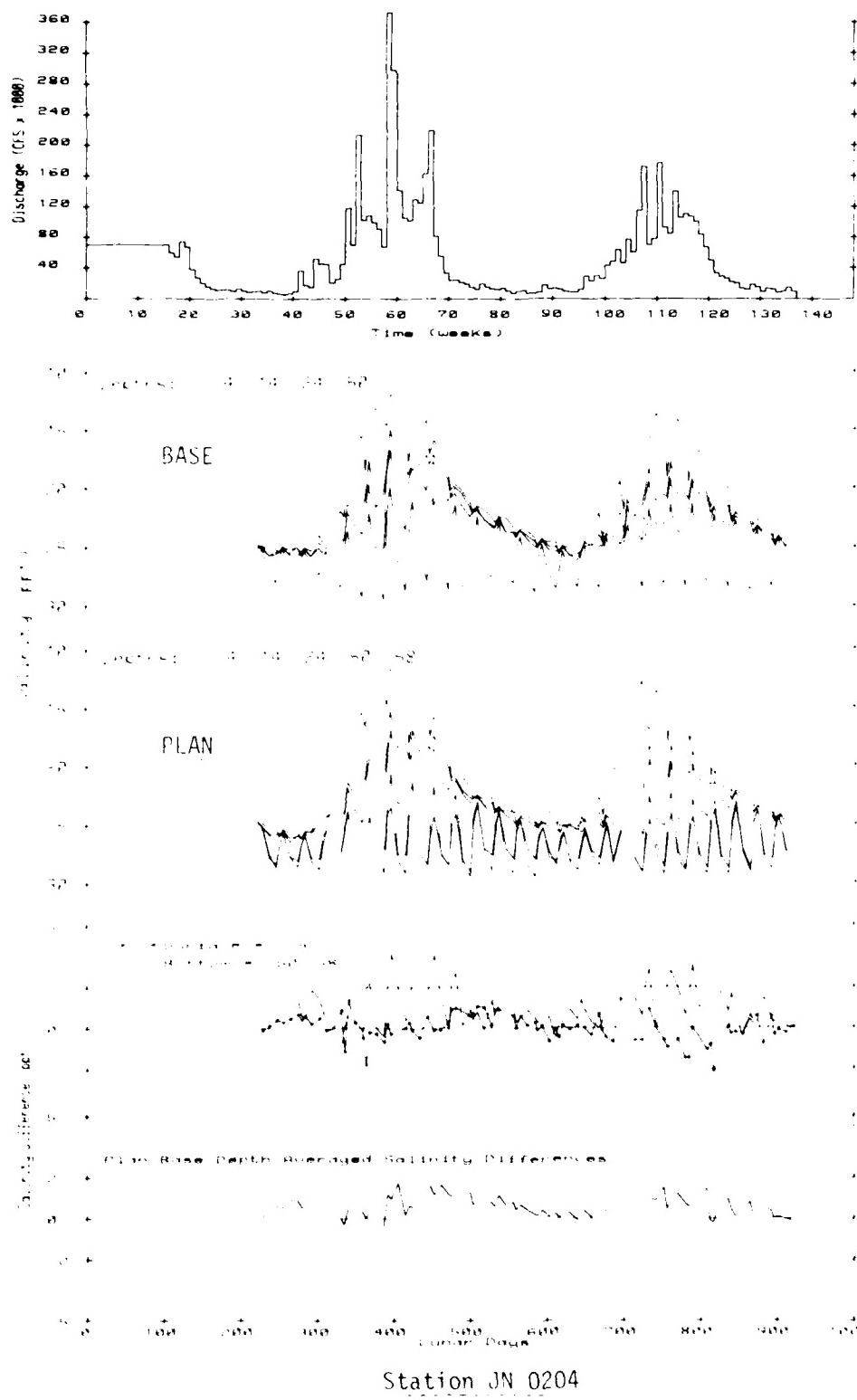
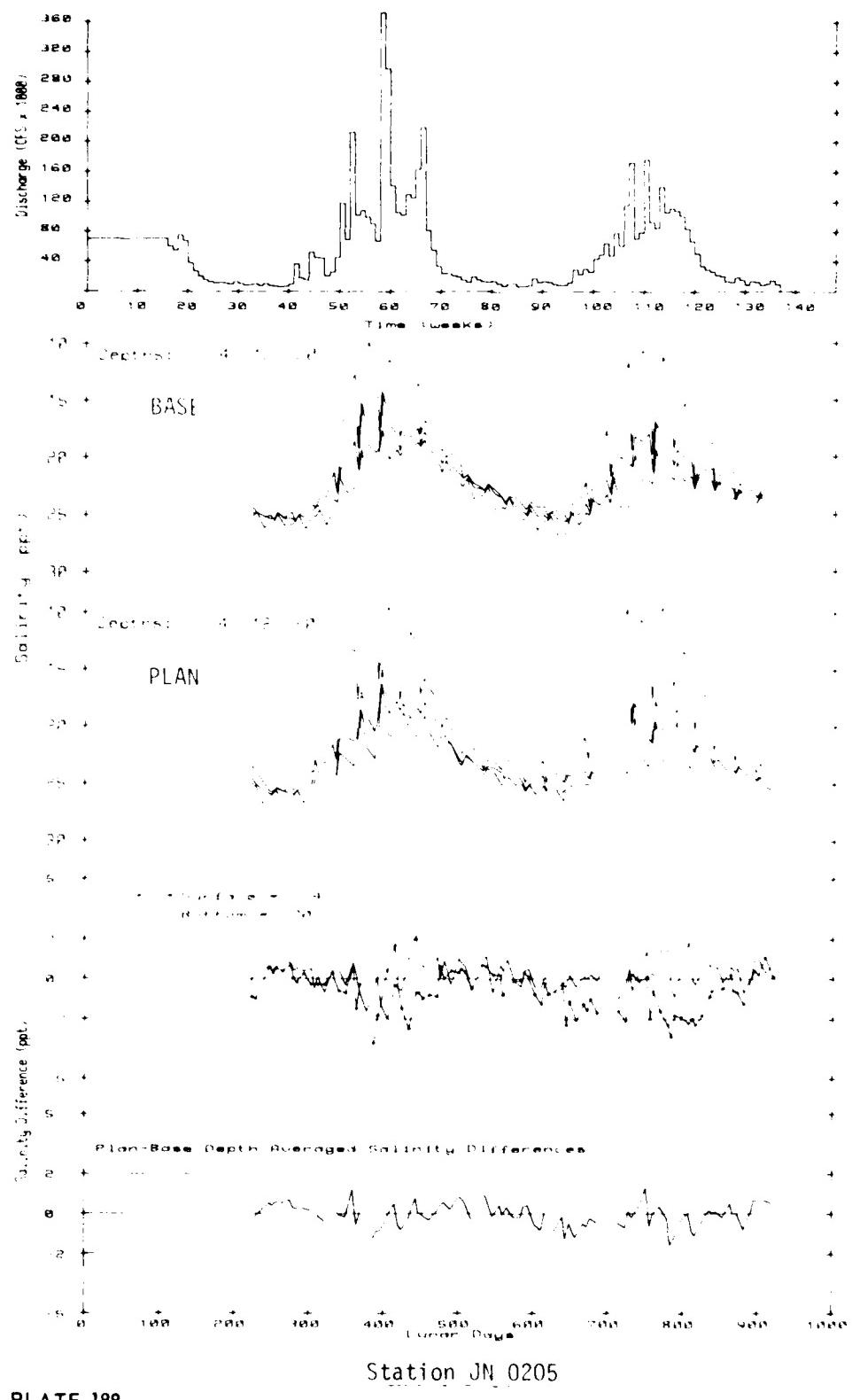
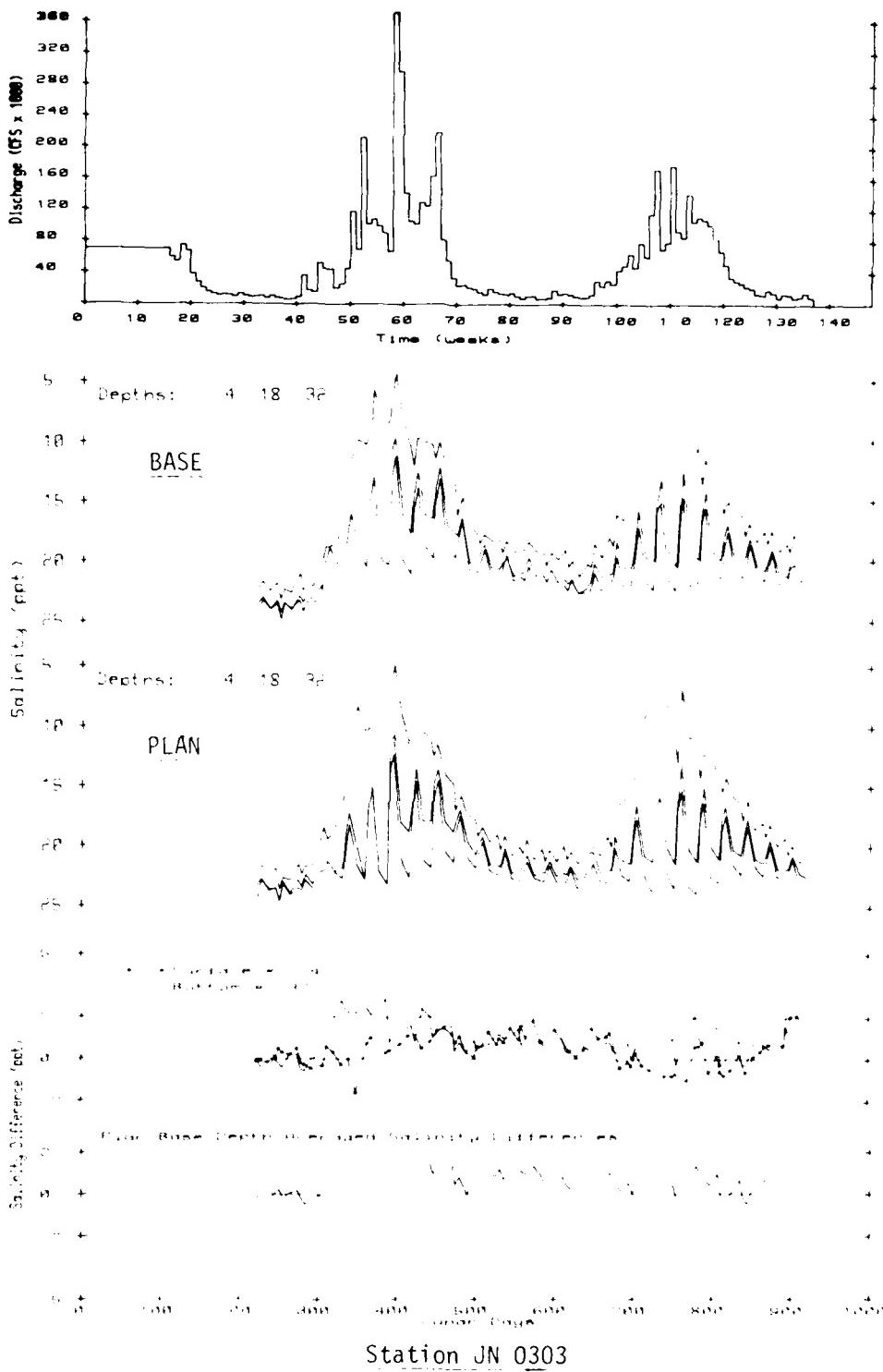


PLATE 187





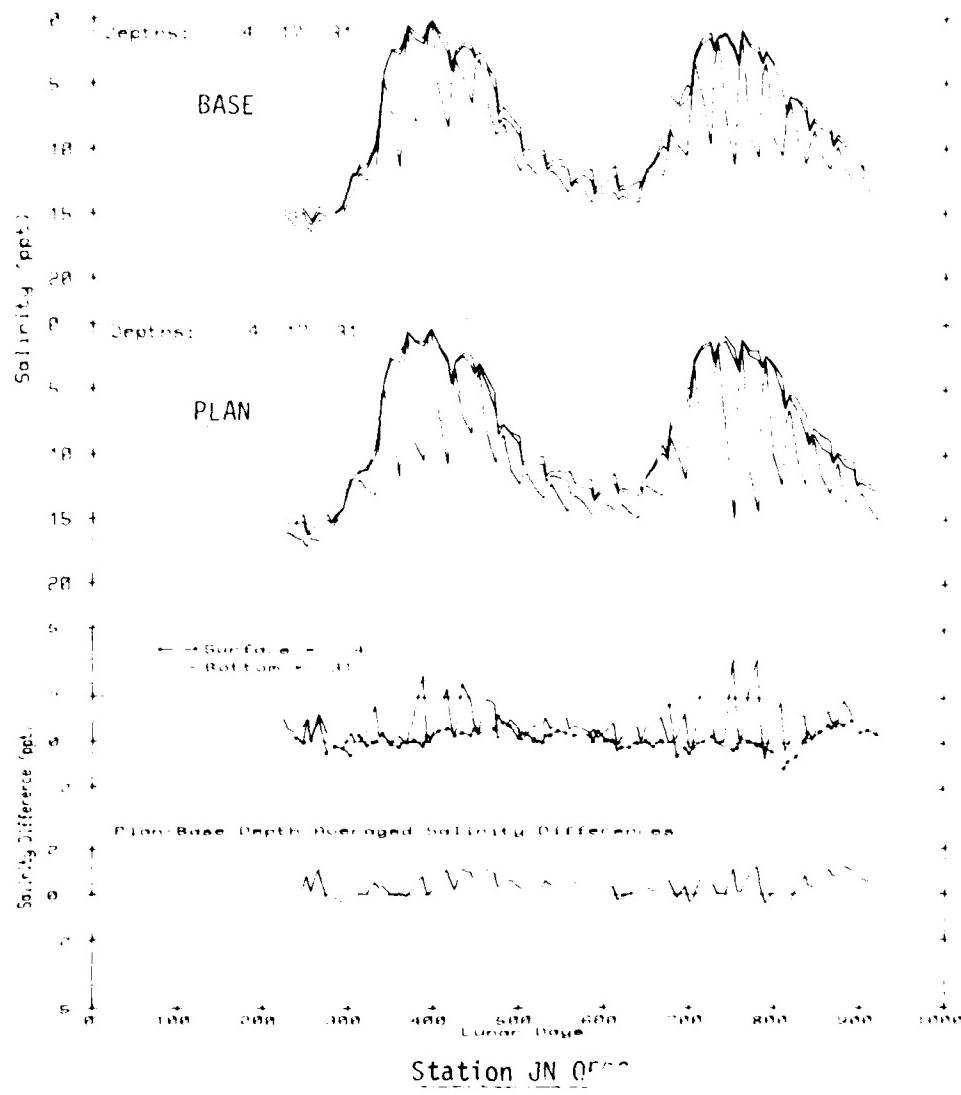
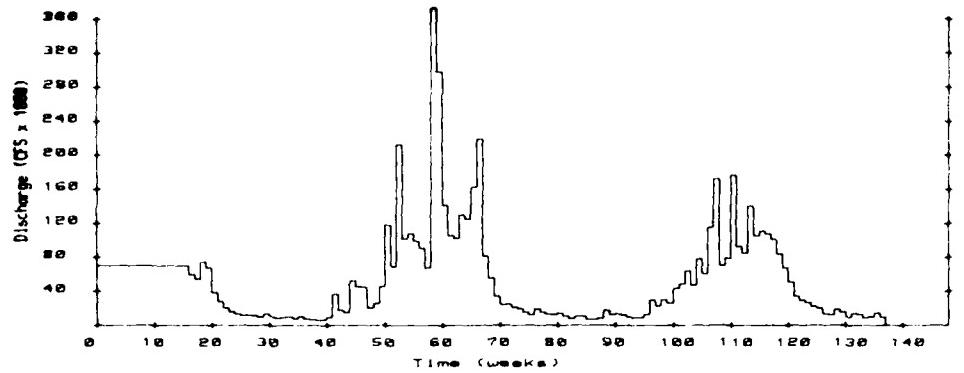
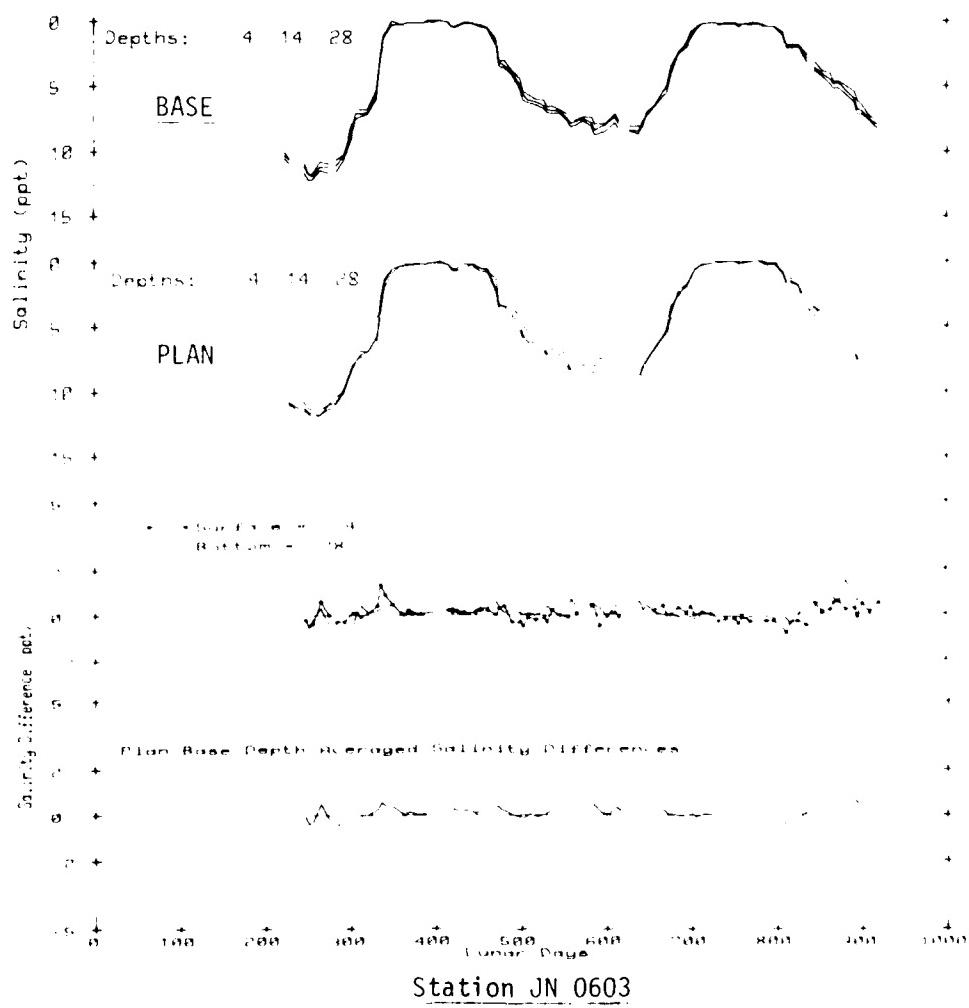
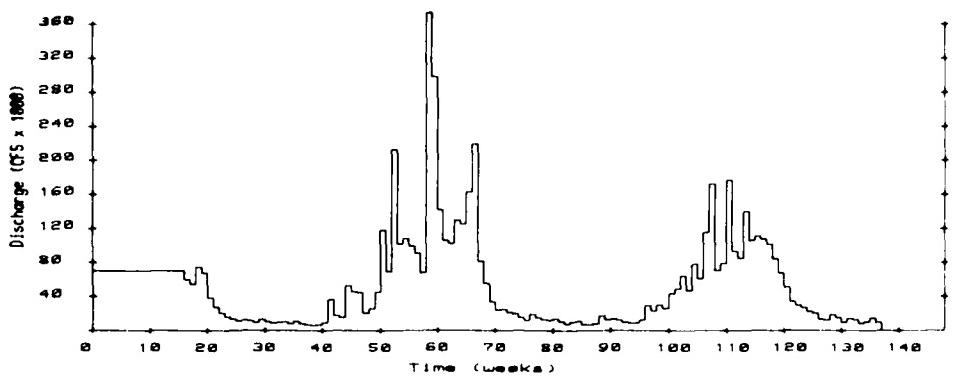


PLATE 190



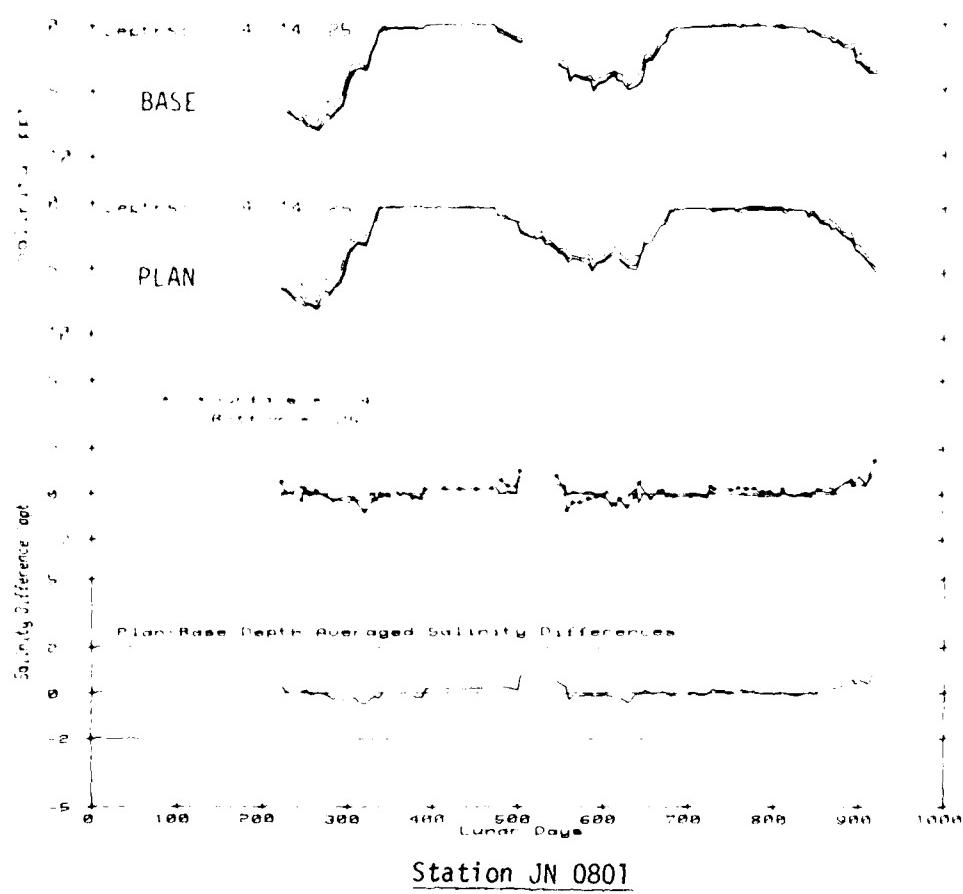
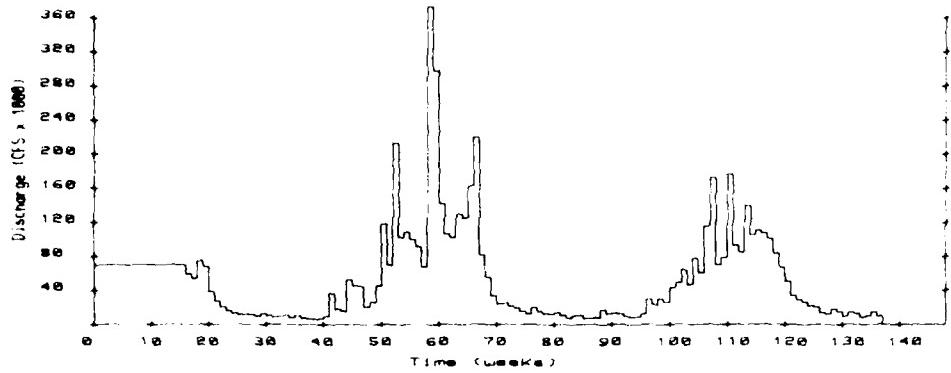


PLATE 192

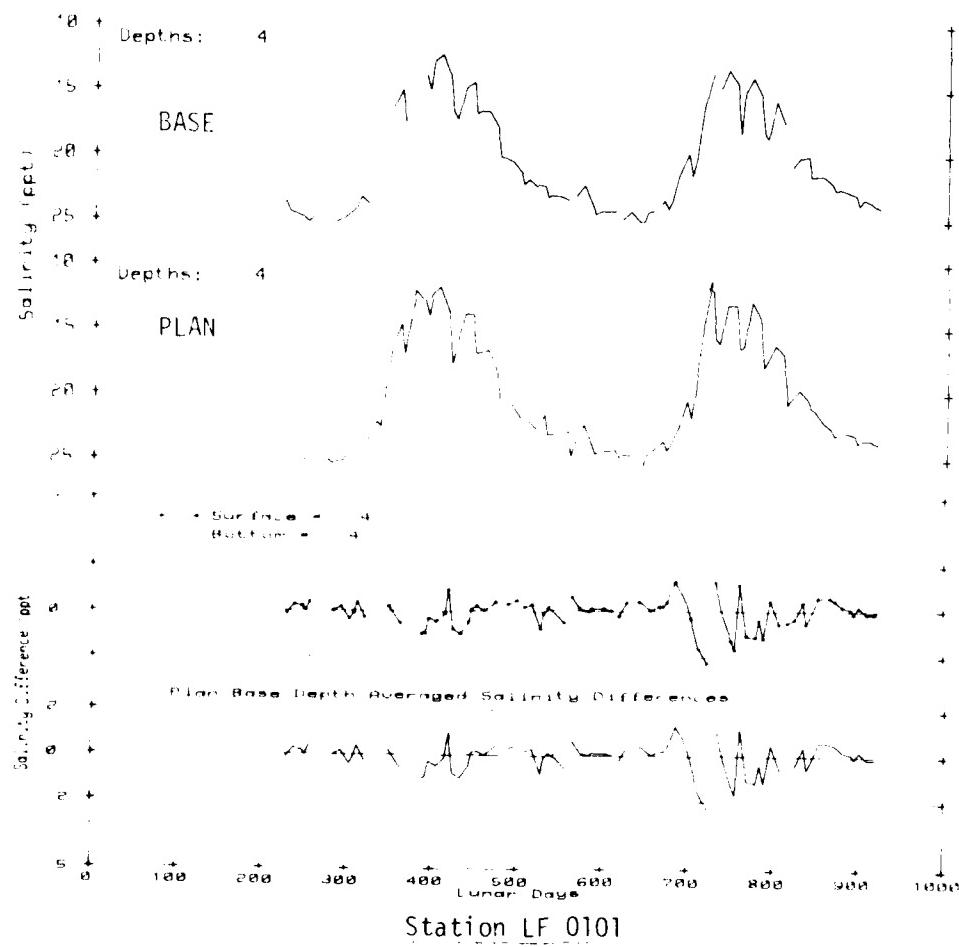
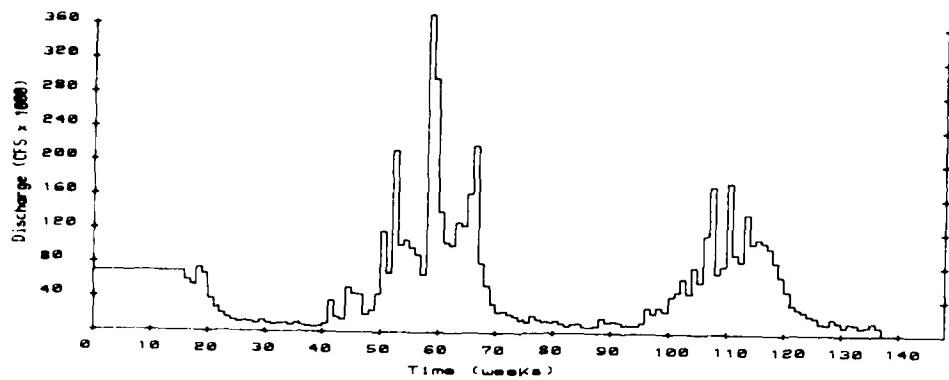
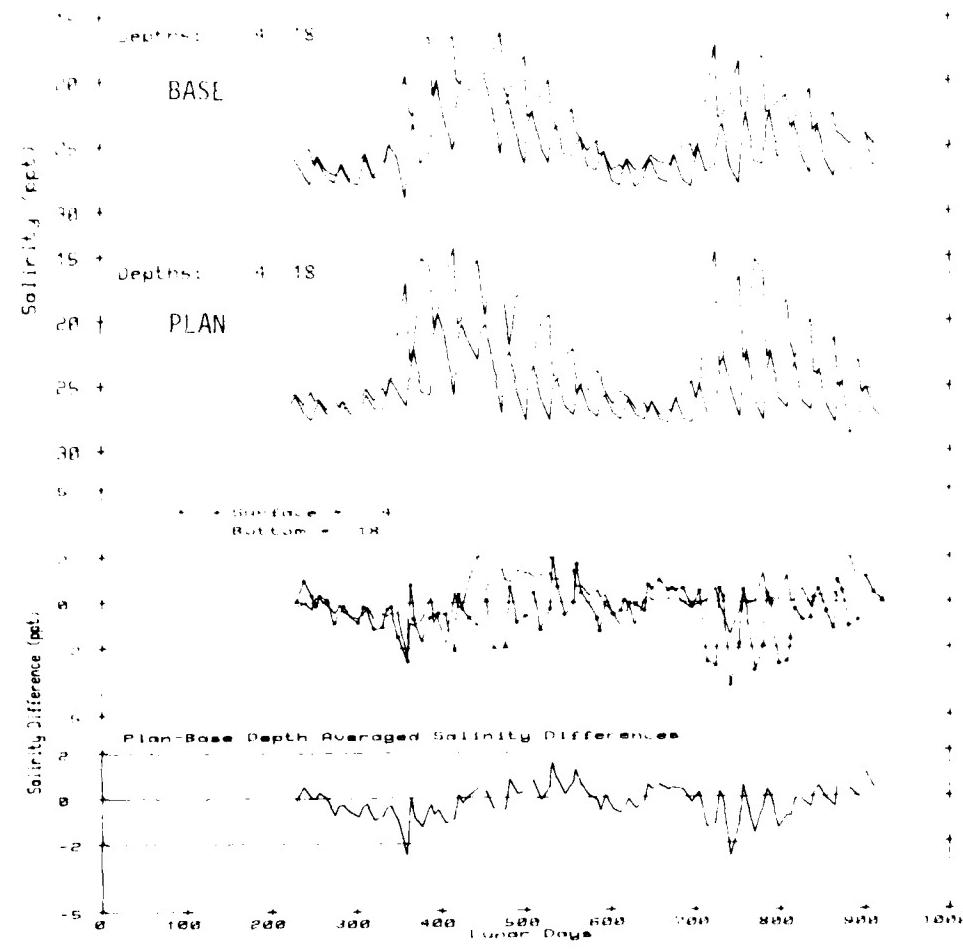
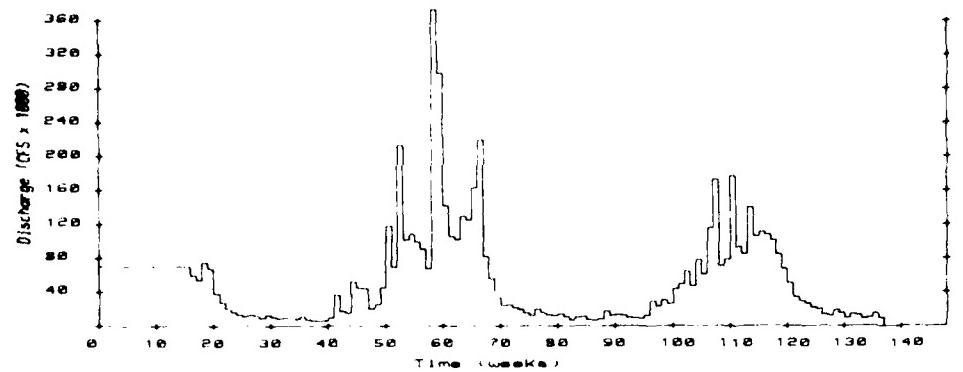
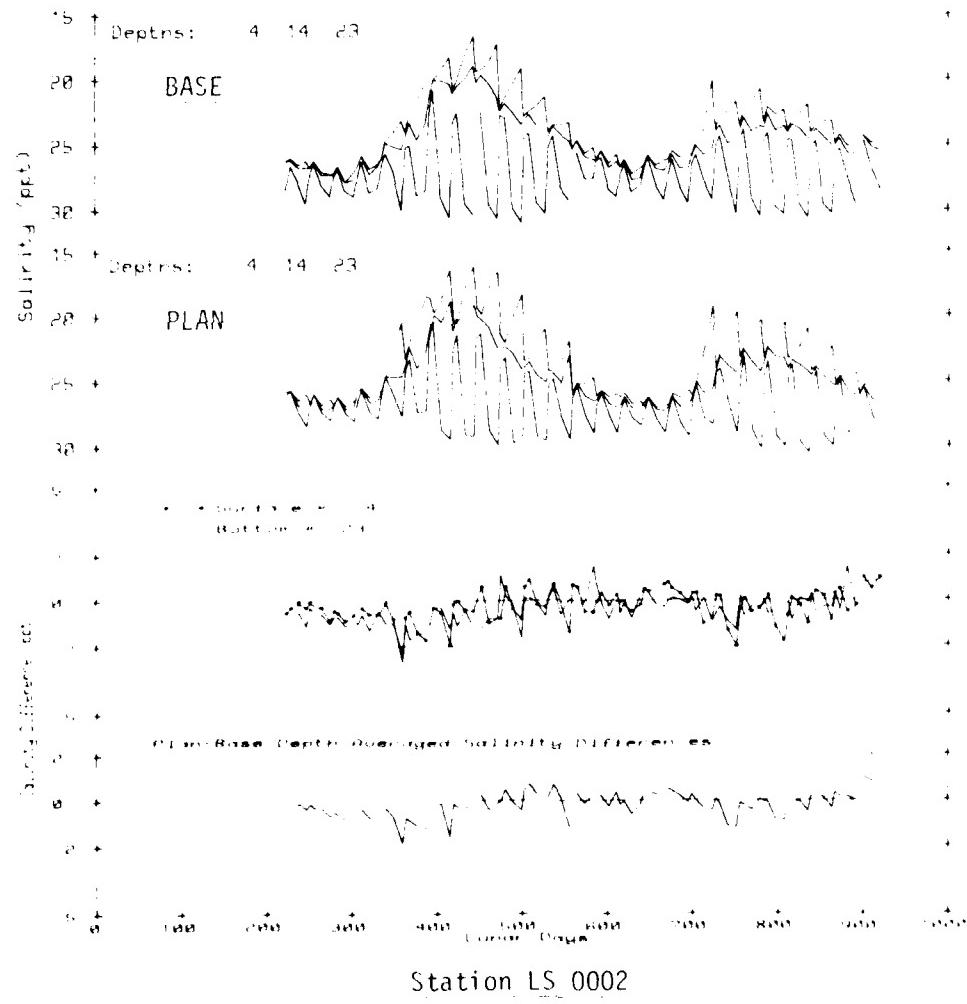
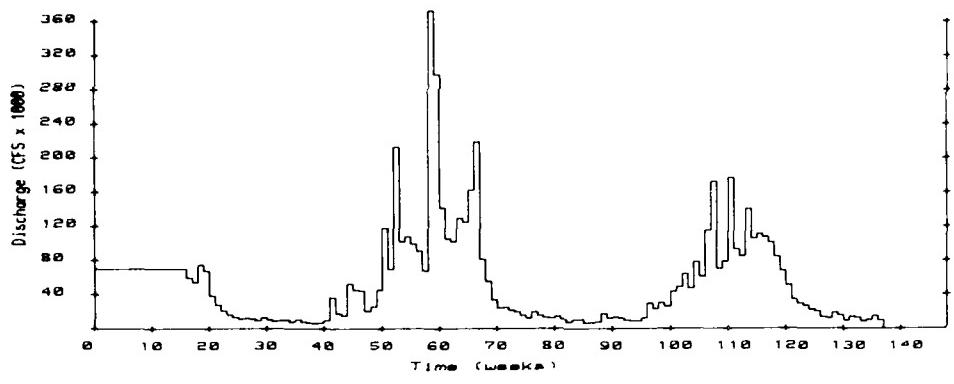


PLATE 193



Station LS 0001

PLATE 194



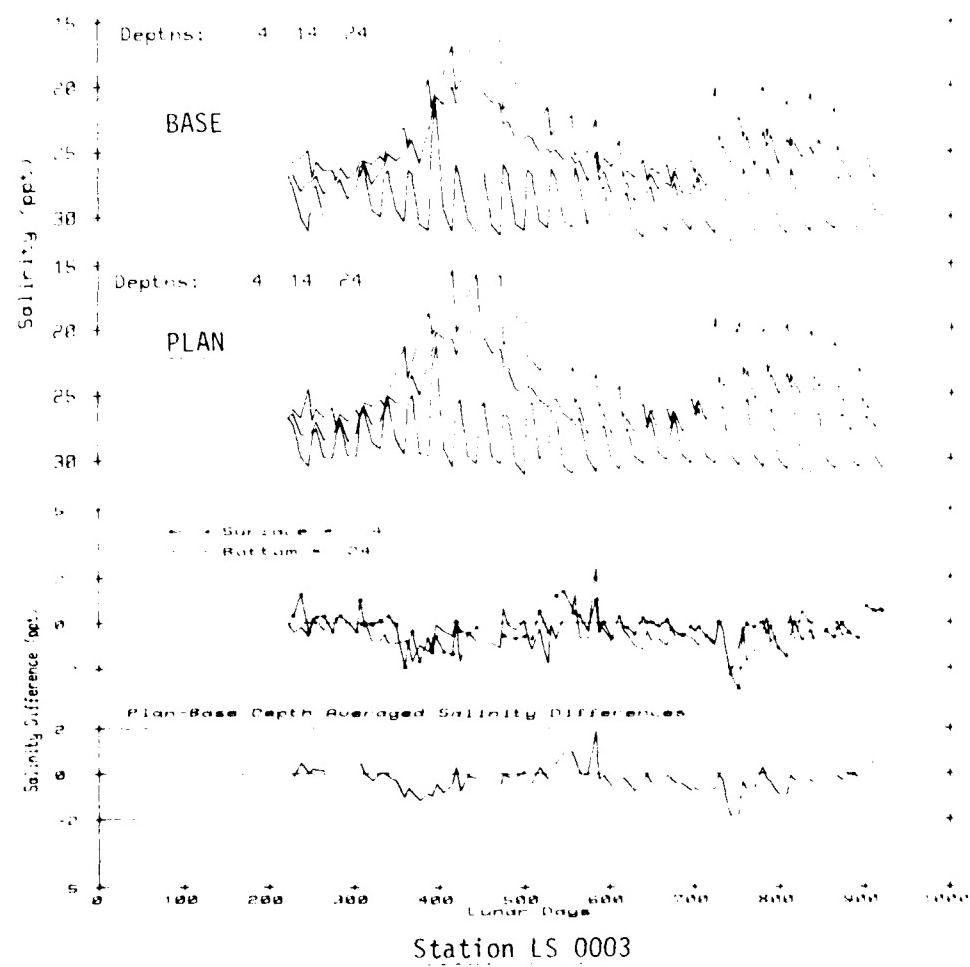
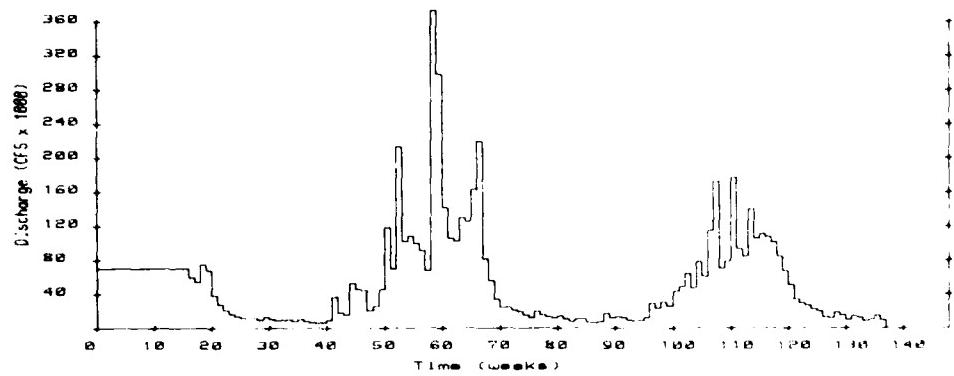
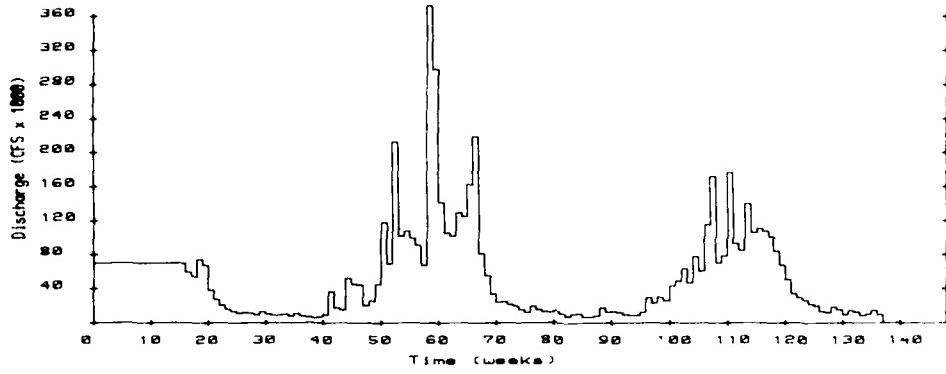


PLATE 196



15 + Depths: 4 18

20 + BASE



Salinity (ppm.)

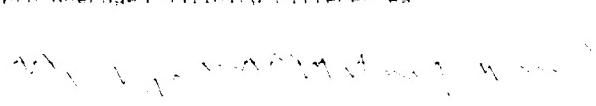
15-4 Depths: 4-18

PP PLAN



Journal of Finance

Open-Source Deep Dive: Understanding and Utilizing TensorFlow.js



Station LS 0004

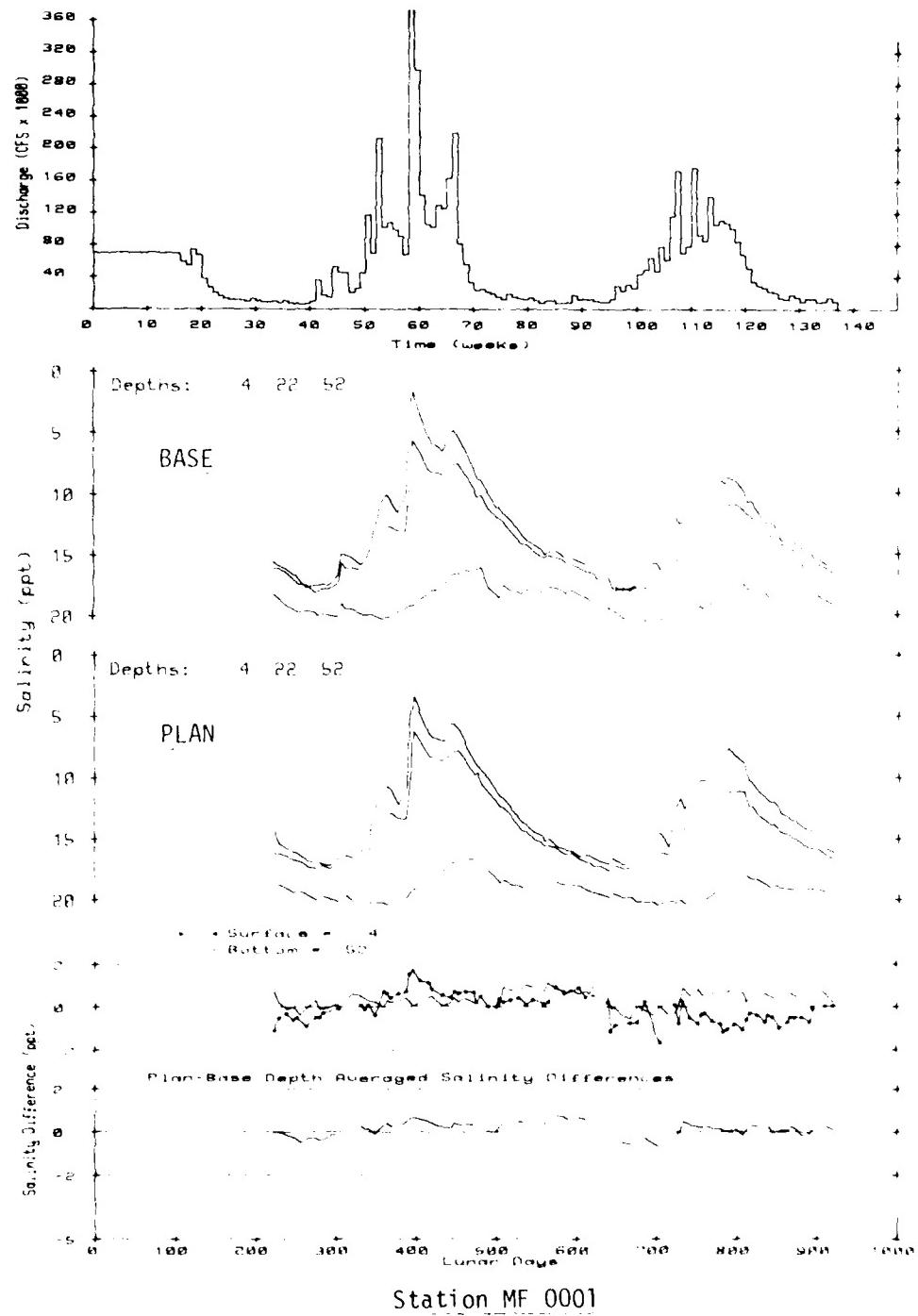
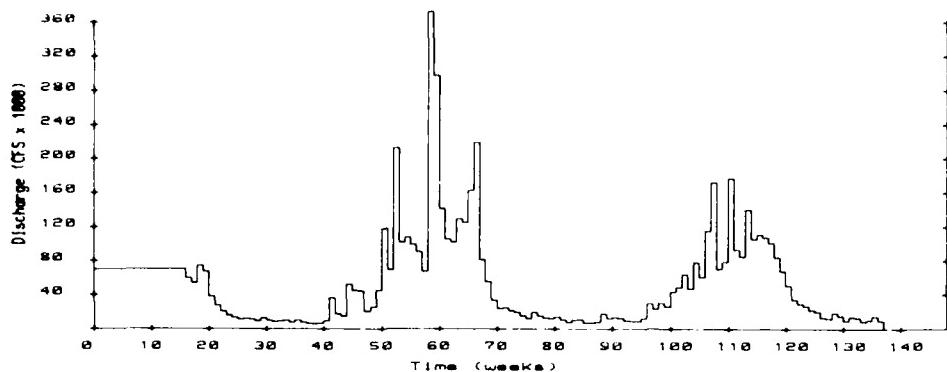


PLATE 198



15 + Depth: 4 14 32 56 111

30 + BASE



PLAN



Station NN 0001

PLATE 199

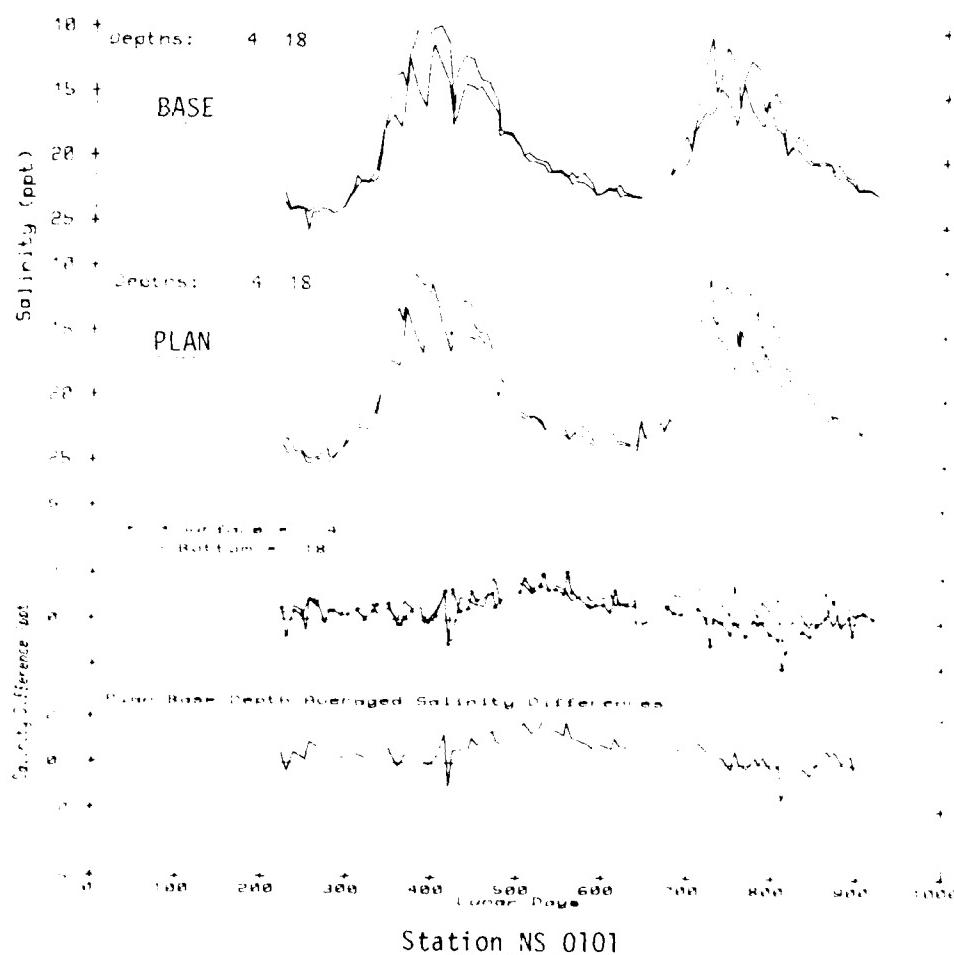
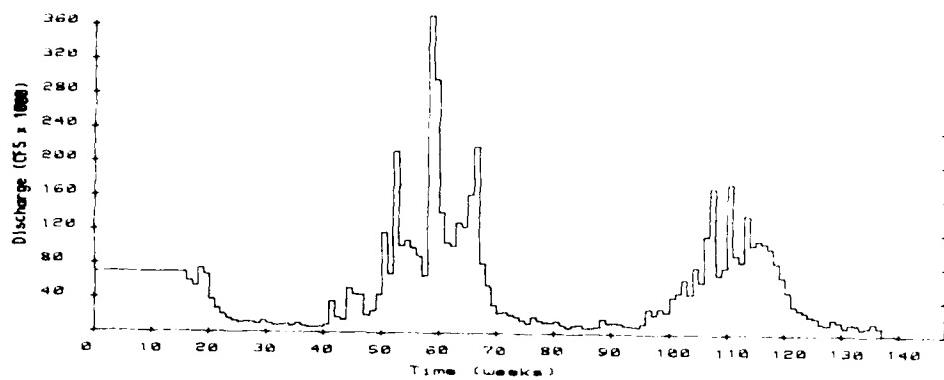


PLATE 200

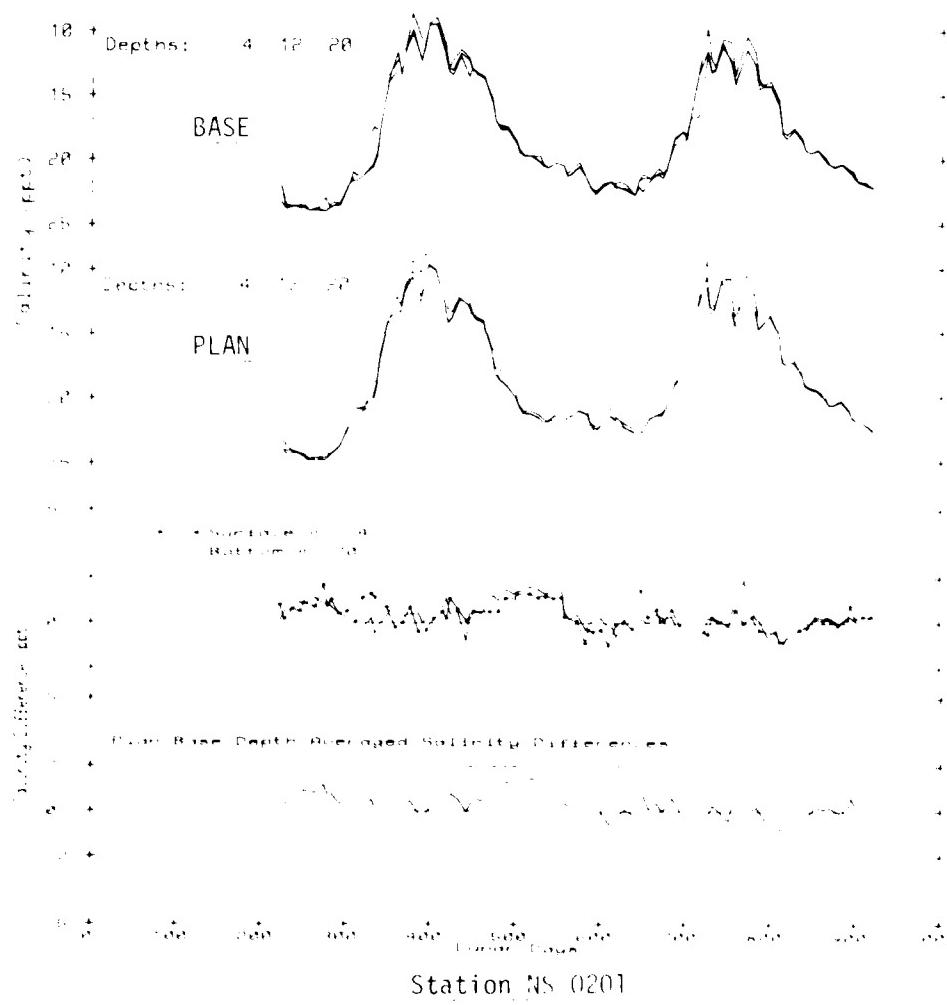
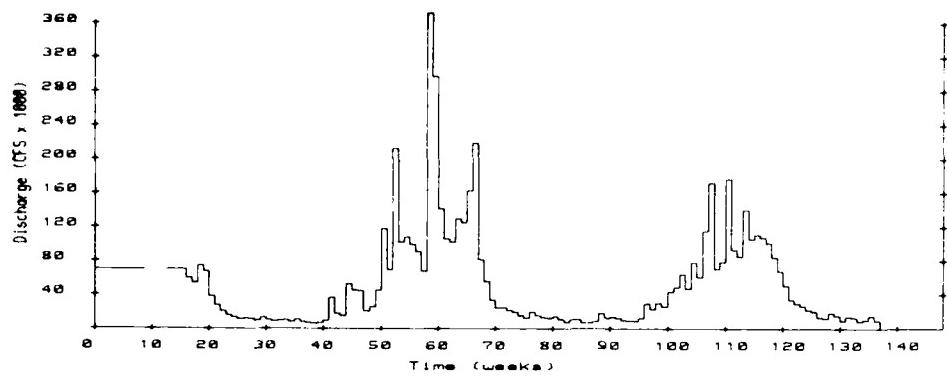


PLATE 201

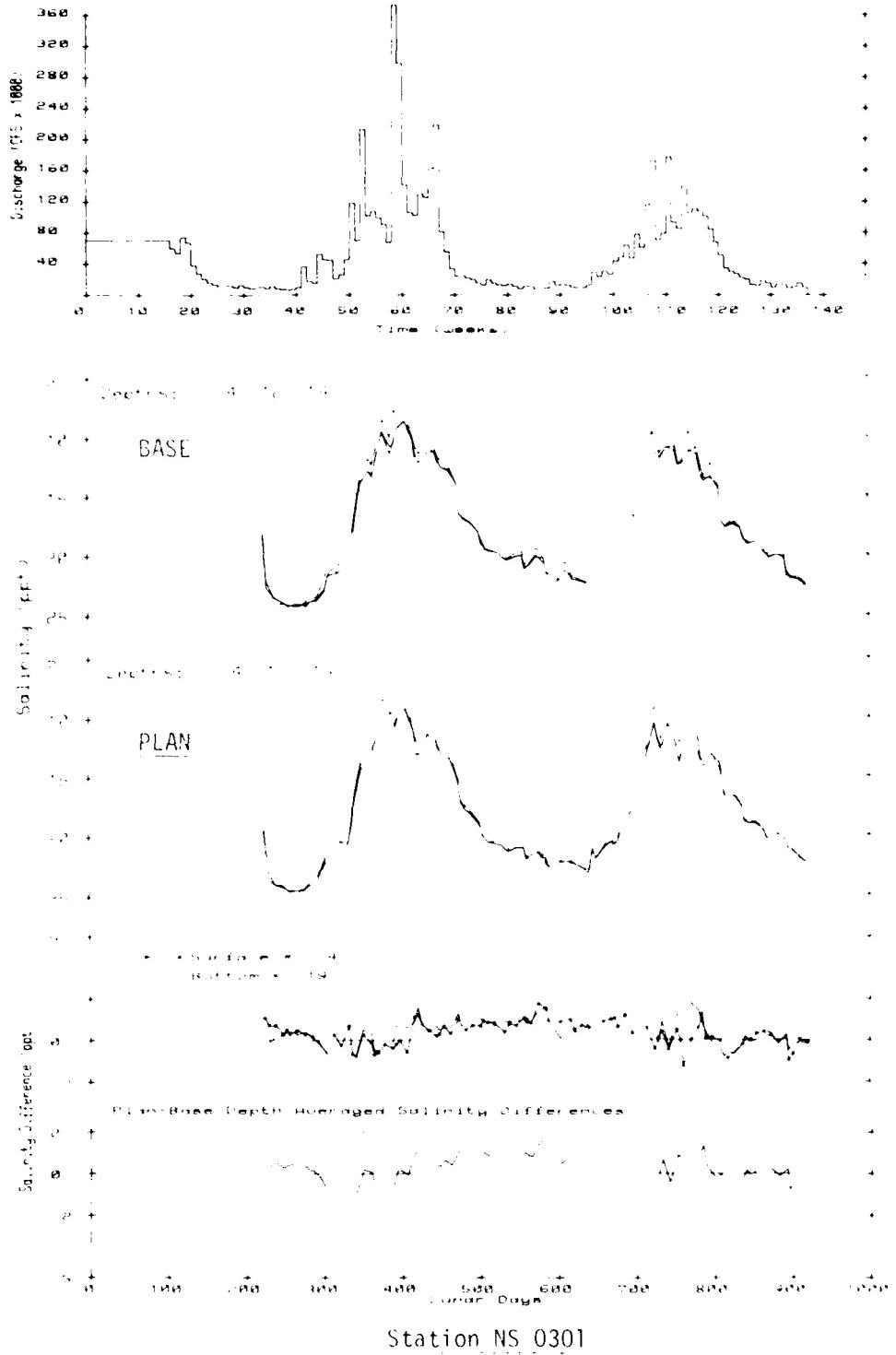
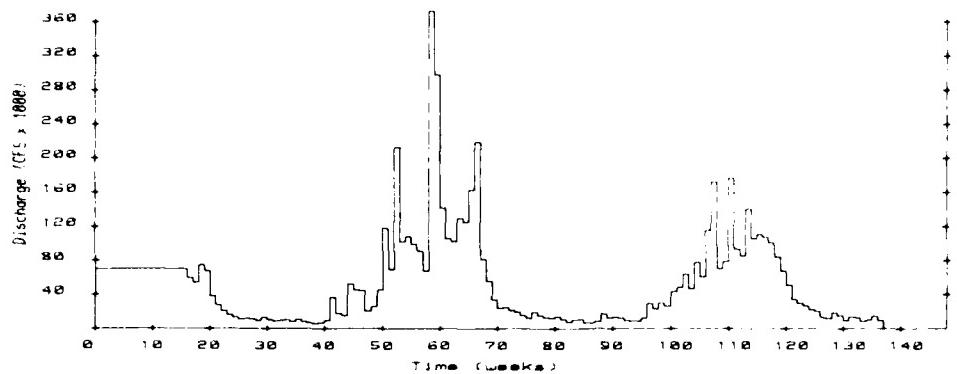


PLATE 202



BASE

Pi A

REFERENCES

Table 8: Benthic Depth-Stratified Salinity Differences

100 200 300 400 500 600 700 800 900 1000

Station NS 0401

PLATE 203

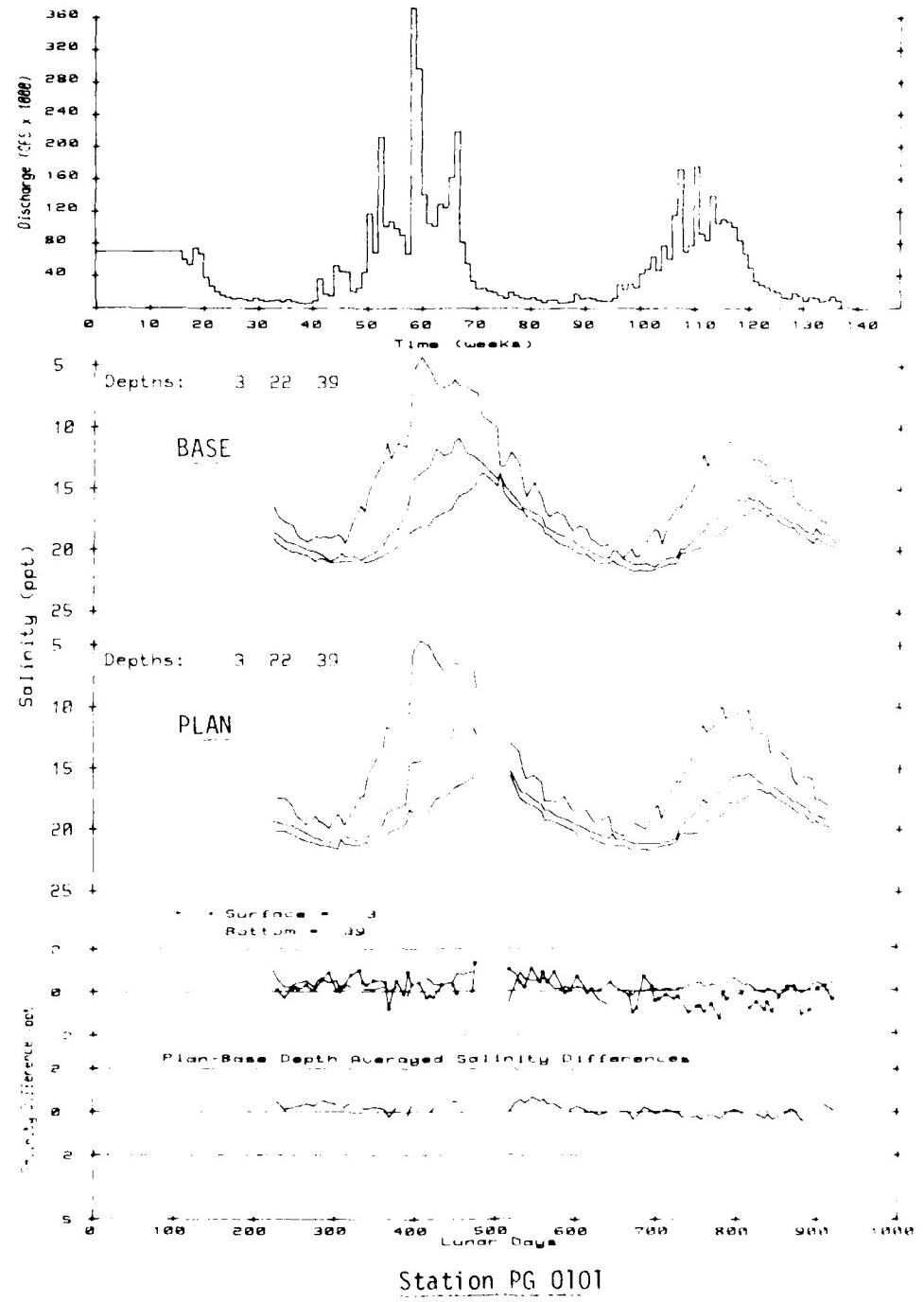


PLATE 204

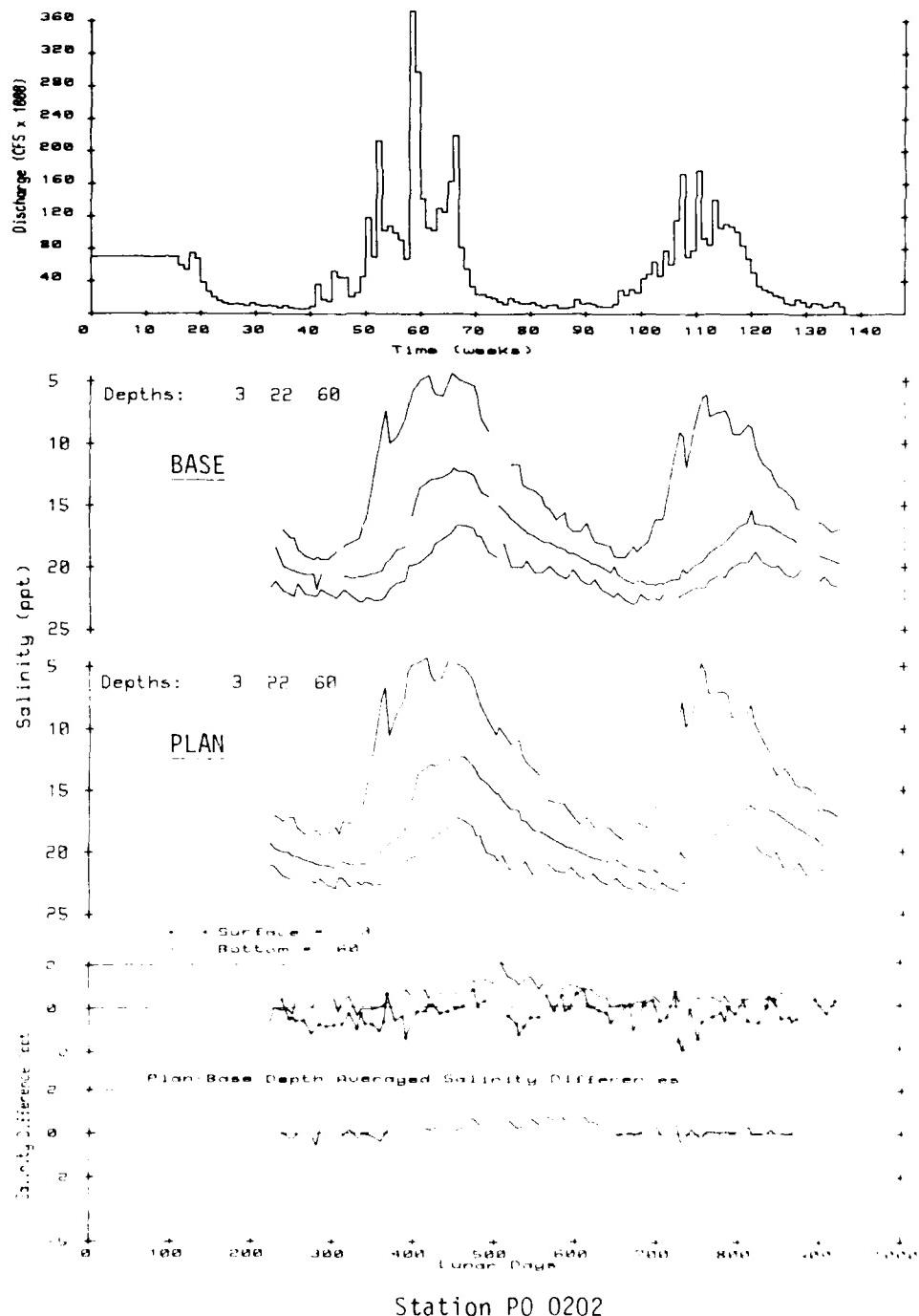


PLATE 205

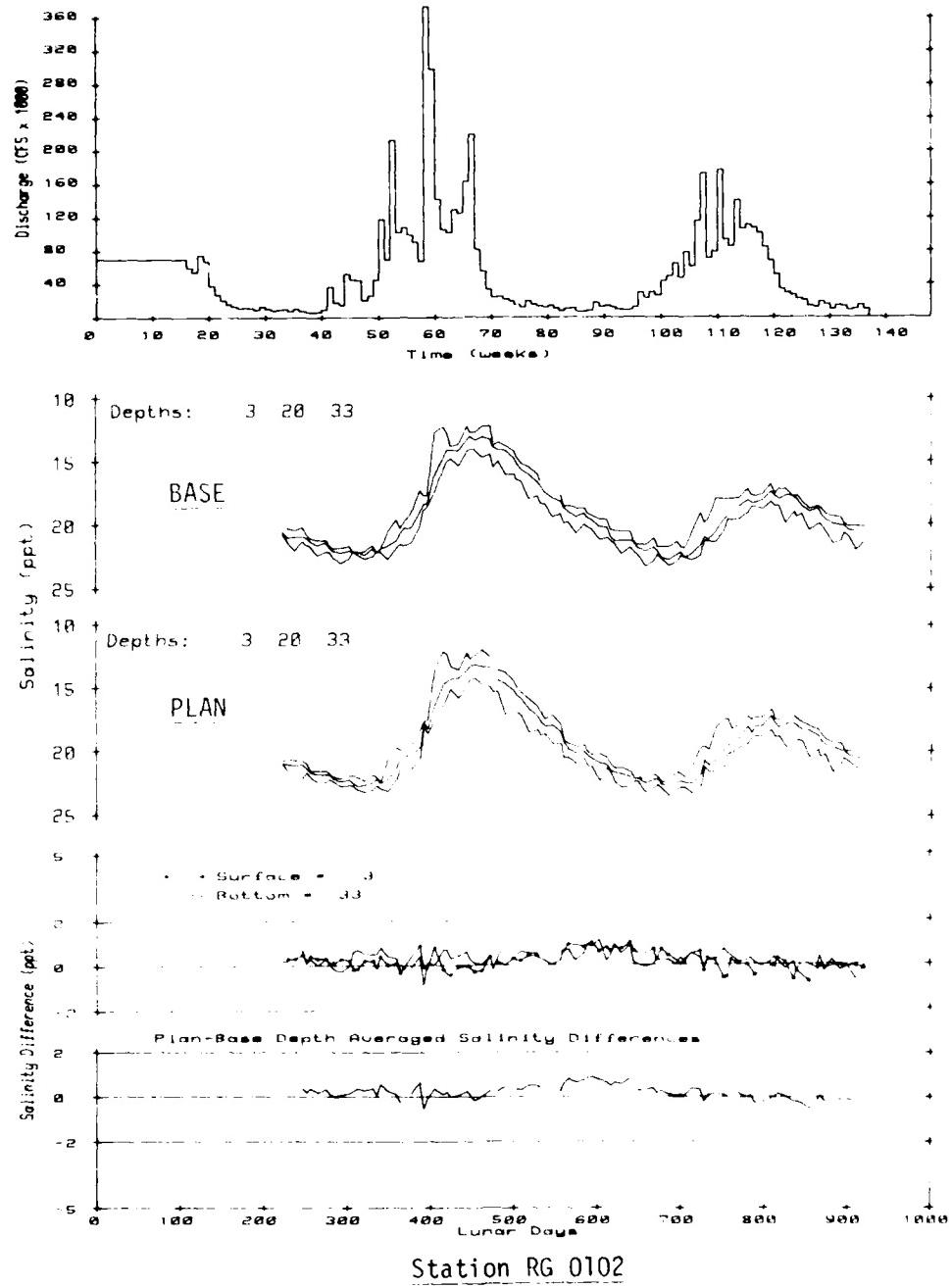


PLATE 206

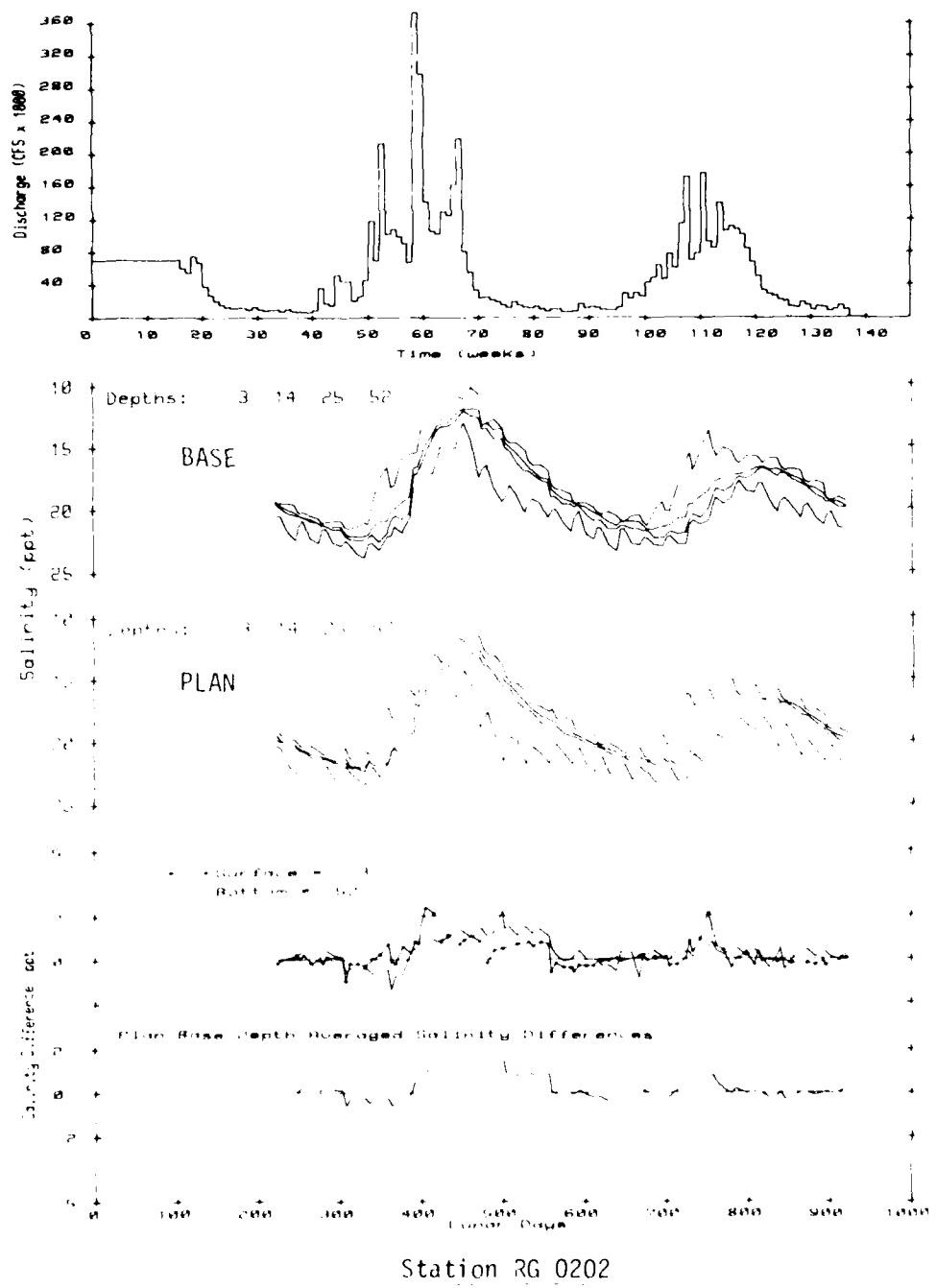


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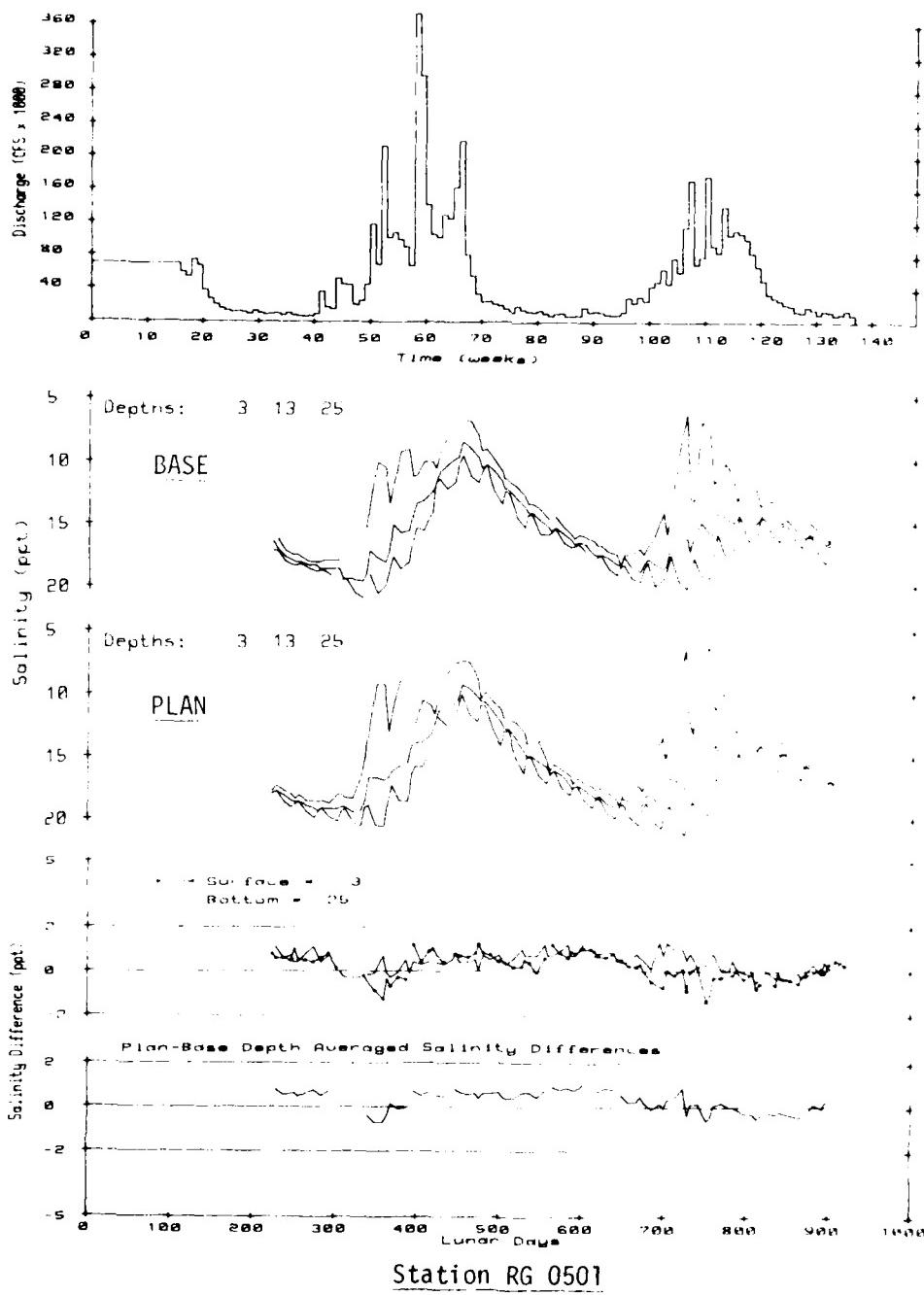
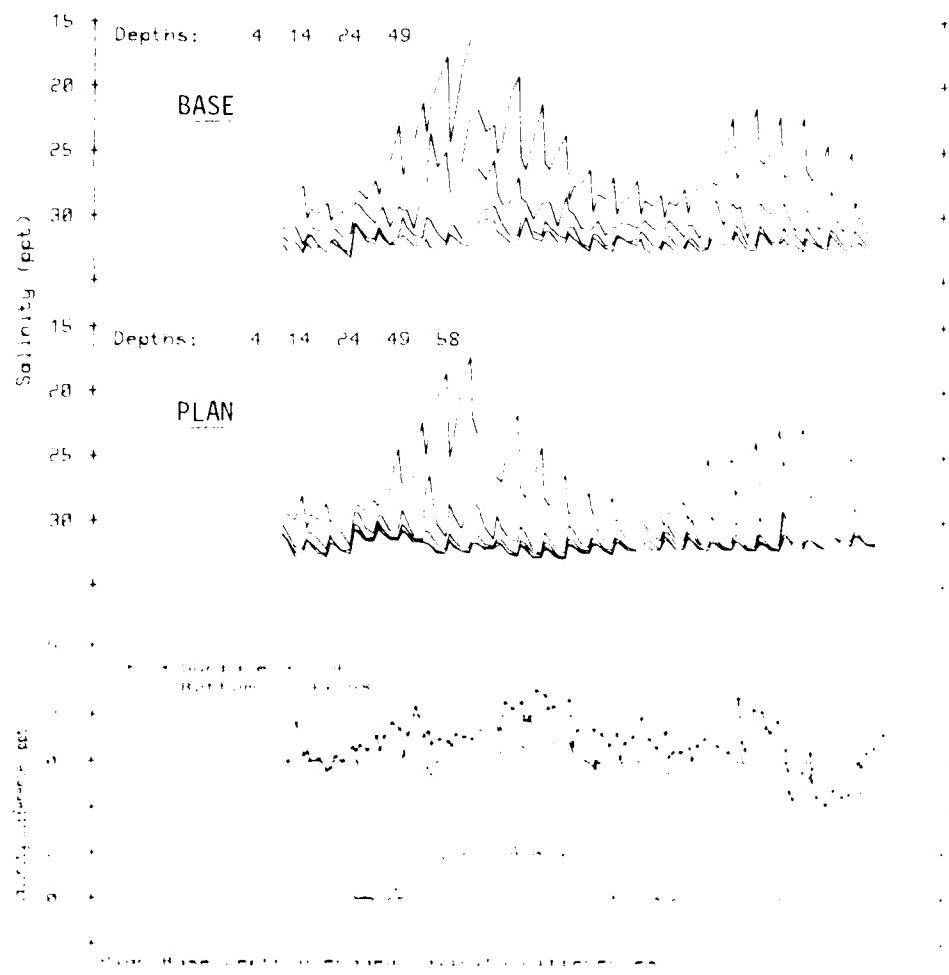
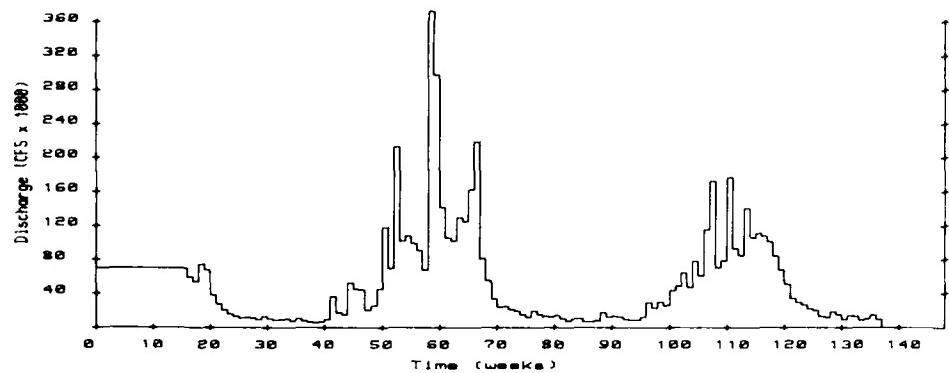


PLATE 208



Station IS 0002

PLATE 209

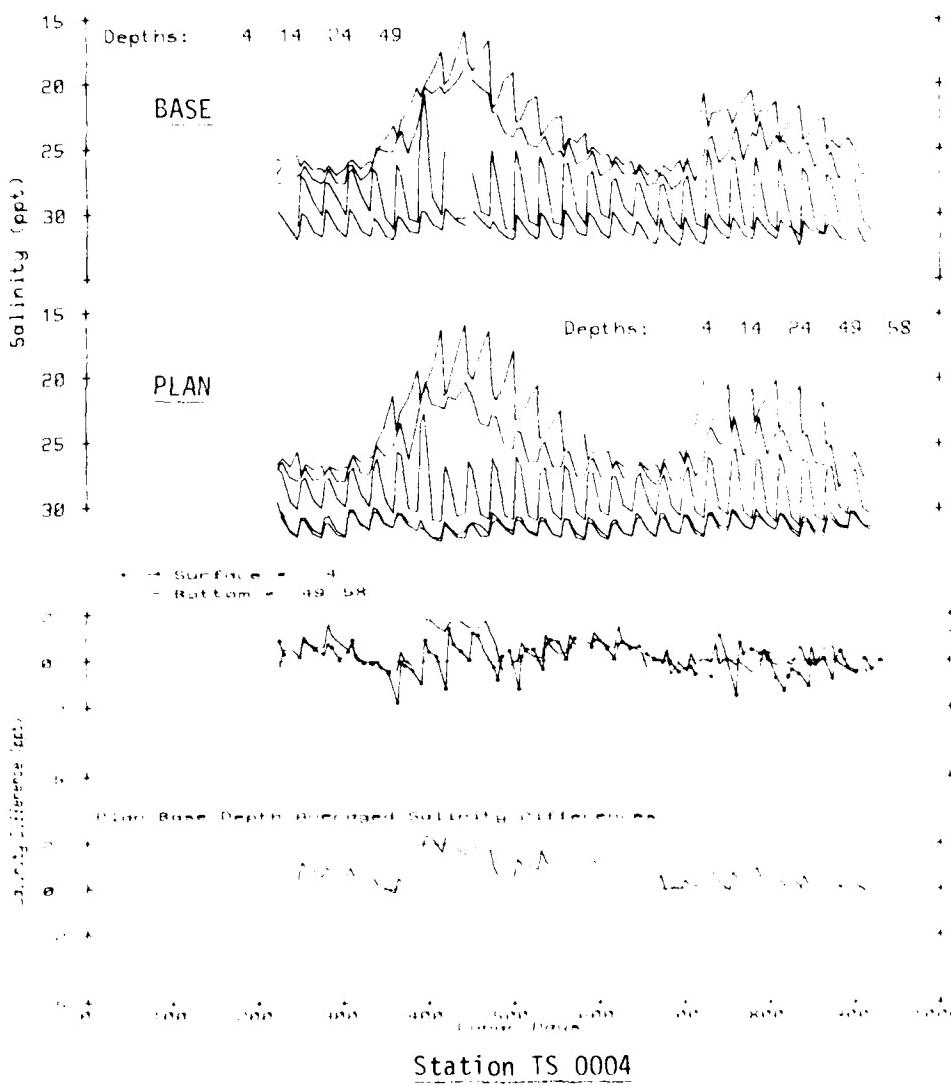
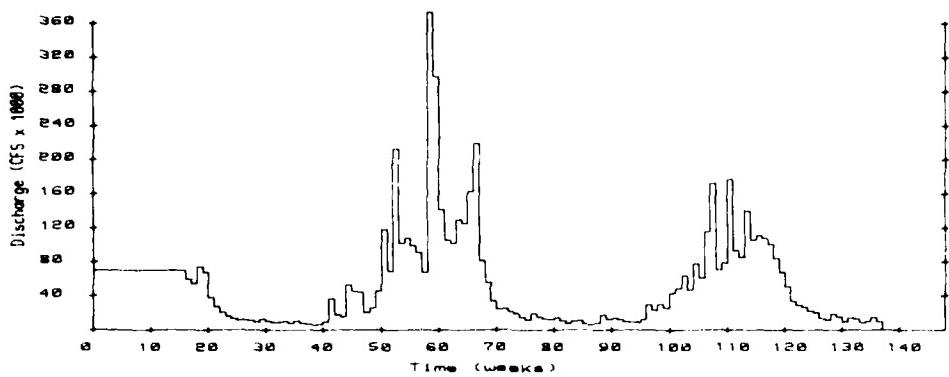


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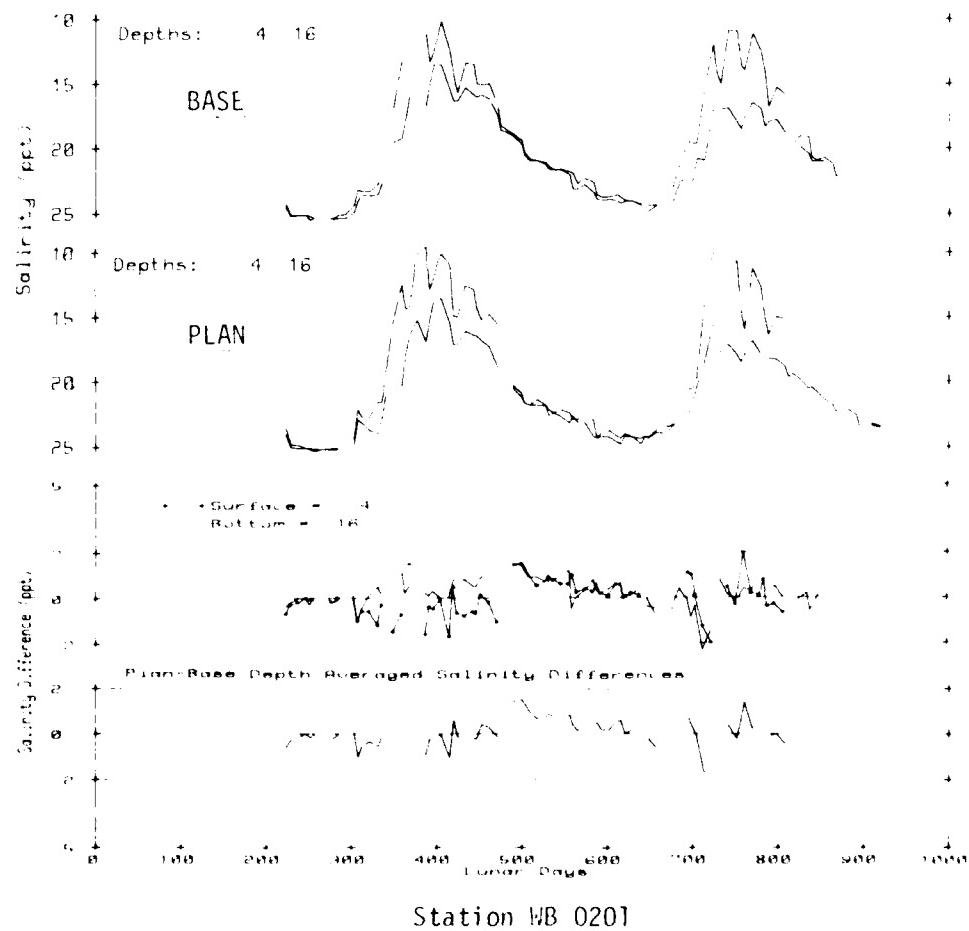
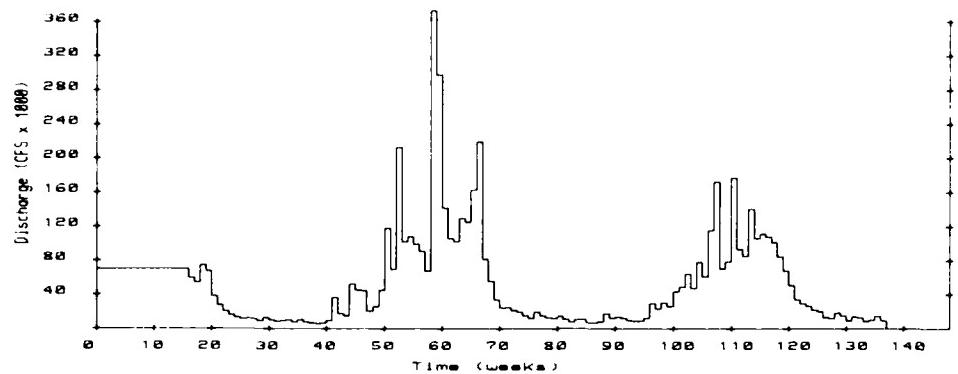


PLATE 211

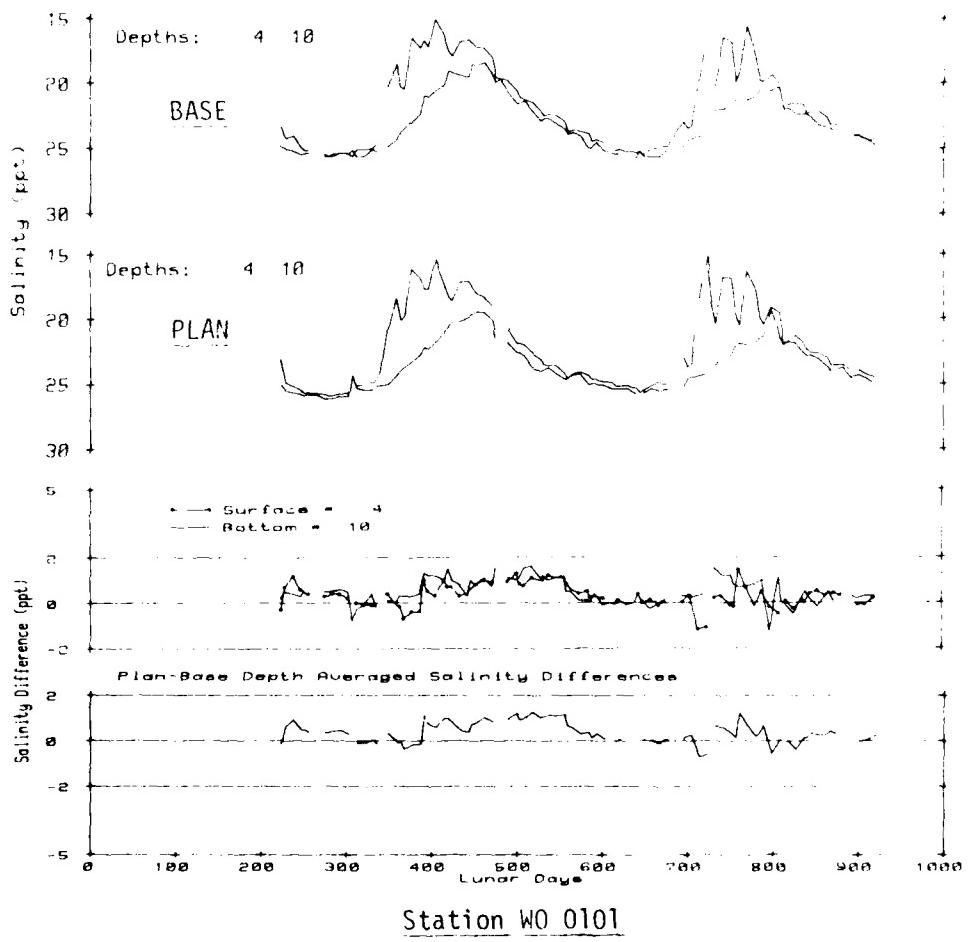
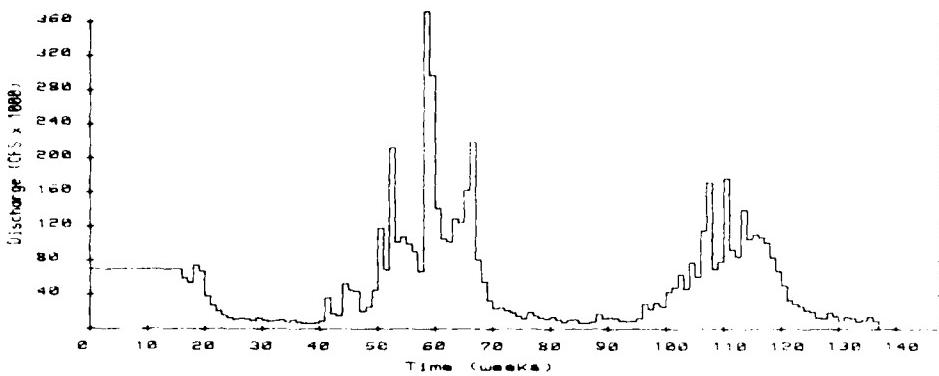


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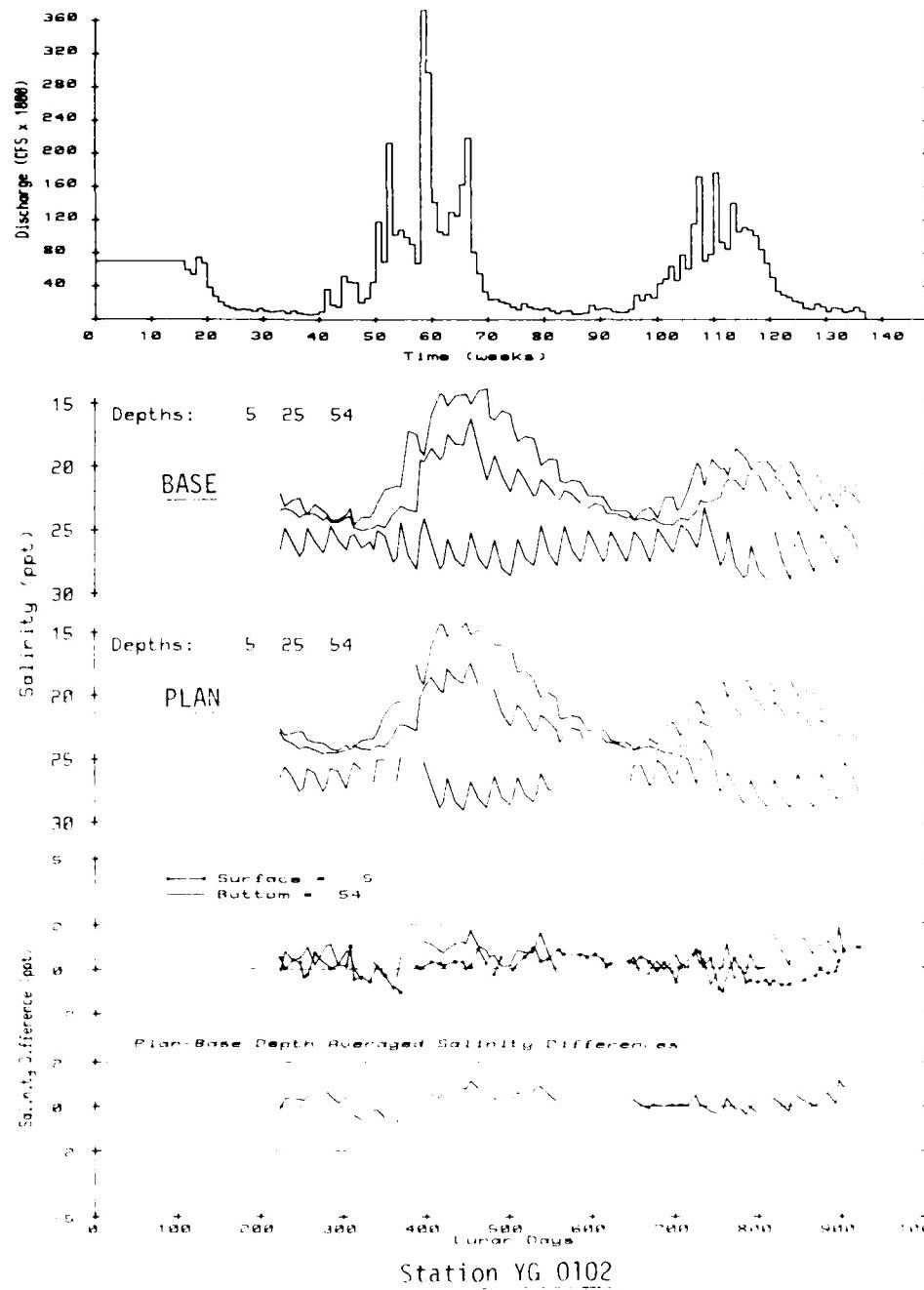


PLATE 213

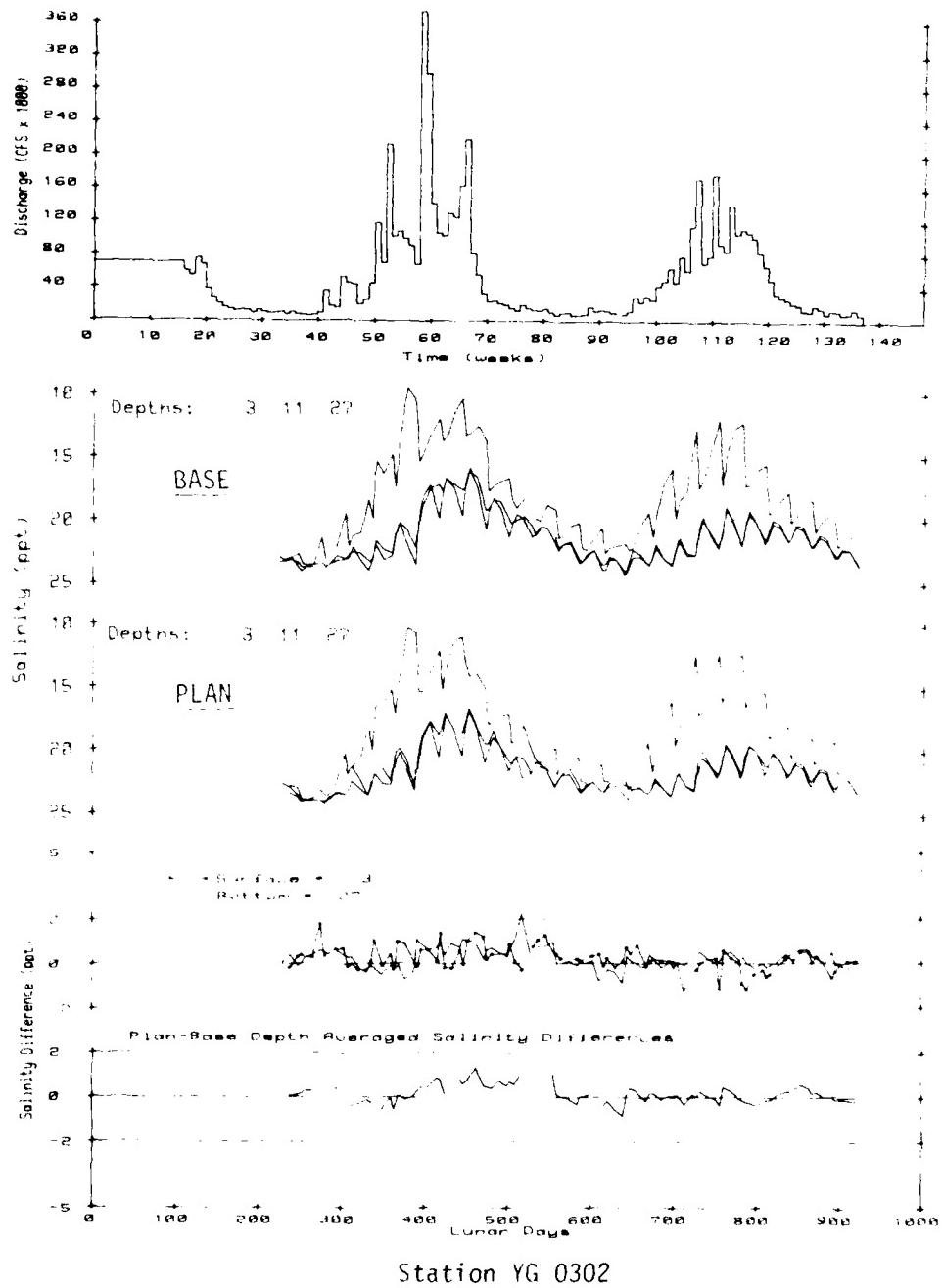


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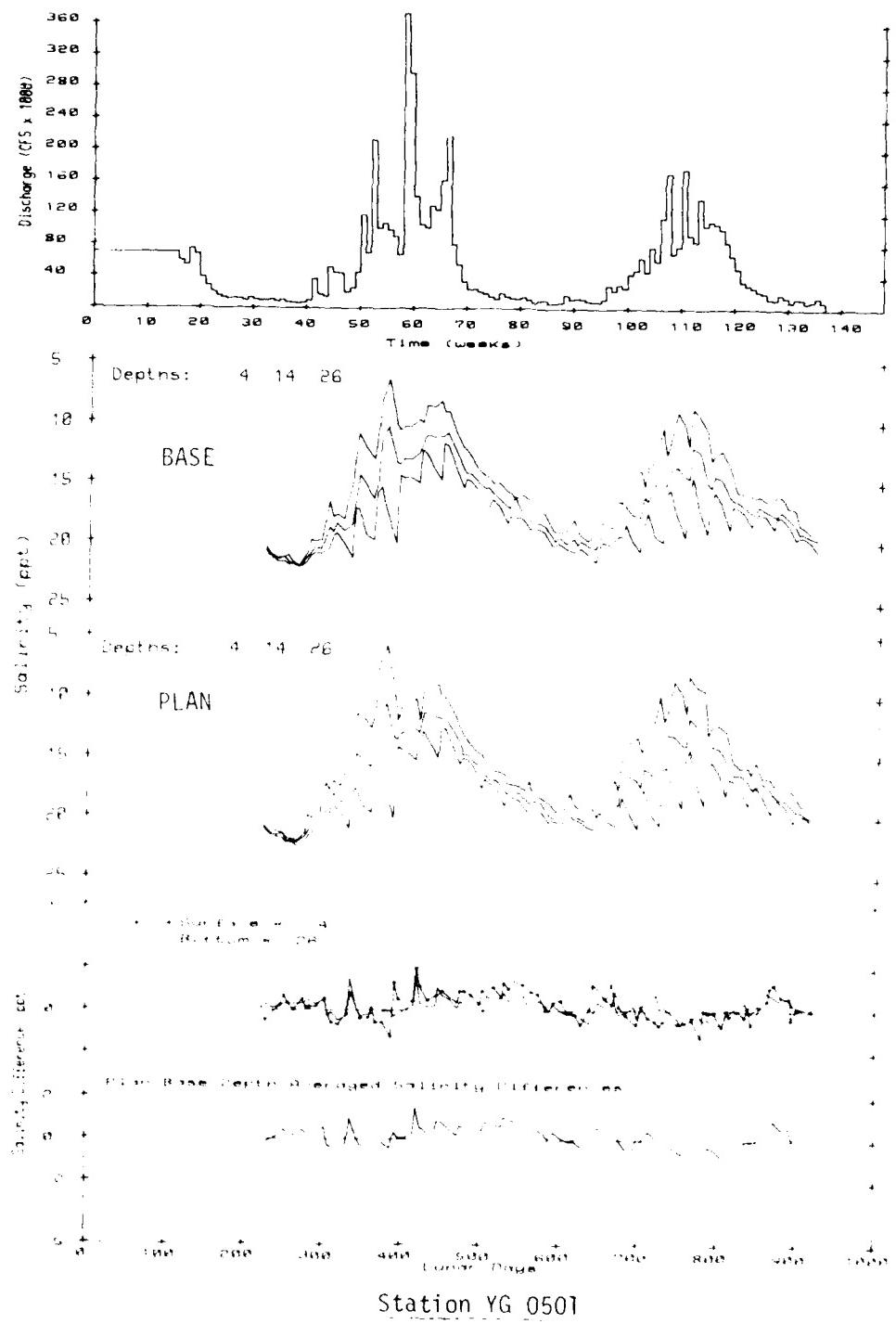


PLATE 215

BASE TEST TIDE 1 PLAN TEST TIDE 1

BASE TEST TIDE 10 PLAN TEST TIDE 10

BASE TEST TIDE 28 PLAN TEST TIDE 28

BASE TEST TIDE 48 PLAN TEST TIDE 48

NORFOLK HARBOR STUDY

**ISOHALINES FOR
JAMES RIVER**

TIDE 1, 10, 28, AND 48
LOW FLOW CONDITION

BASE TEST

TIDE 1

PLAN TEST

TIDE 1

BASE TEST

TIDE 10

PLAN TEST

TIDE 10

BASE TEST

TIDE 28

PLAN TEST

TIDE 28

BASE TEST

TIDE 48

PLAN TEST

TIDE 48

NORFOLK HARBOR STUDY

ISOHALINES FOR
JAMES RIVER

TIDE 1, 10, 28, AND 48
HIGH FLOW CONDITION

BASE TEST TIDE 1

PLAN TEST TIDE 1

BASE TEST TIDE 10

PLAN TEST TIDE 10

BASE TEST TIDE 28

PLAN TEST TIDE 28

BASE TEST TIDE 48

PLAN TEST TIDE 48

NORFOLK HARBOR STUDY

ISOHALINES FOR
ELIZABETH RIVER

TIDE 1, 10, 28, AND 48
LOW FLOW CONDITION

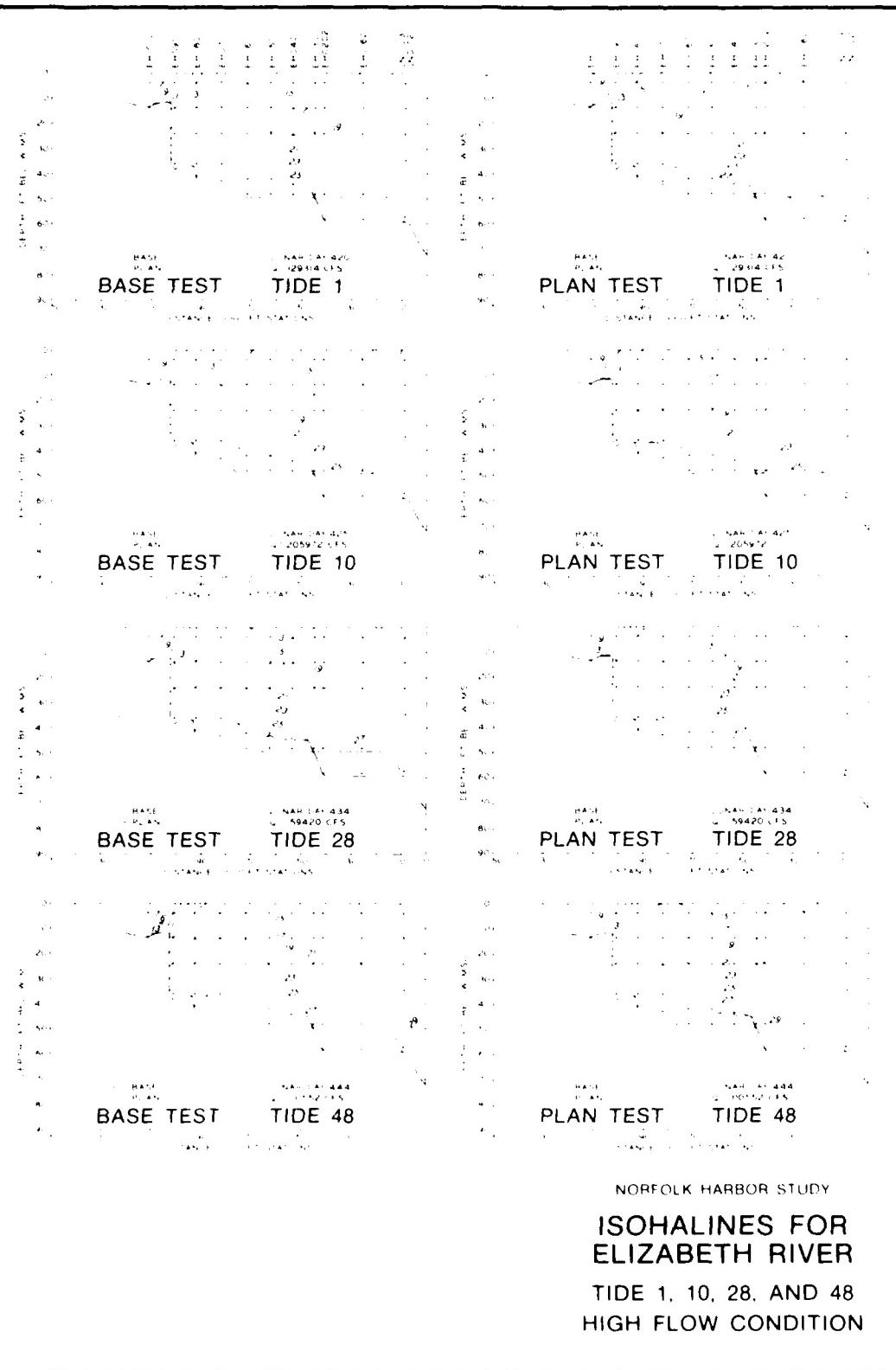


PLATE 219

BASE TEST TIDE 1 PLAN TEST TIDE 1

BASE TEST TIDE 10 PLAN TEST TIDE 10

BASE TEST TIDE 28 PLAN TEST TIDE 28

BASE TEST TIDE 48 PLAN TEST TIDE 48

NORFOLK HARBOR STUDY

ISOHALINES FOR ATLANTIC/
THIMBLE SHOAL CHANNELS

TIDE 1, 10, 28, AND 48
LOW FLOW CONDITION

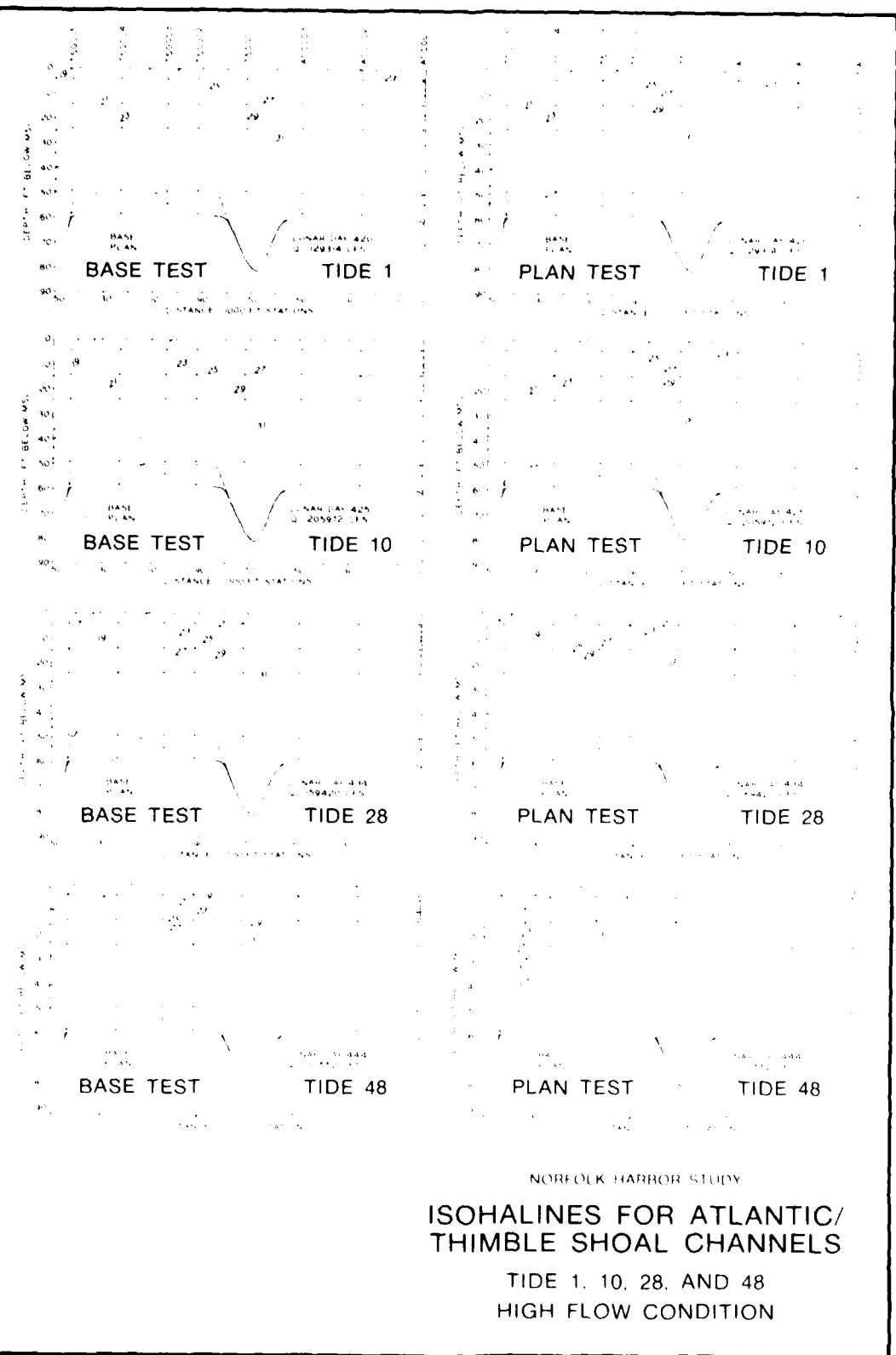
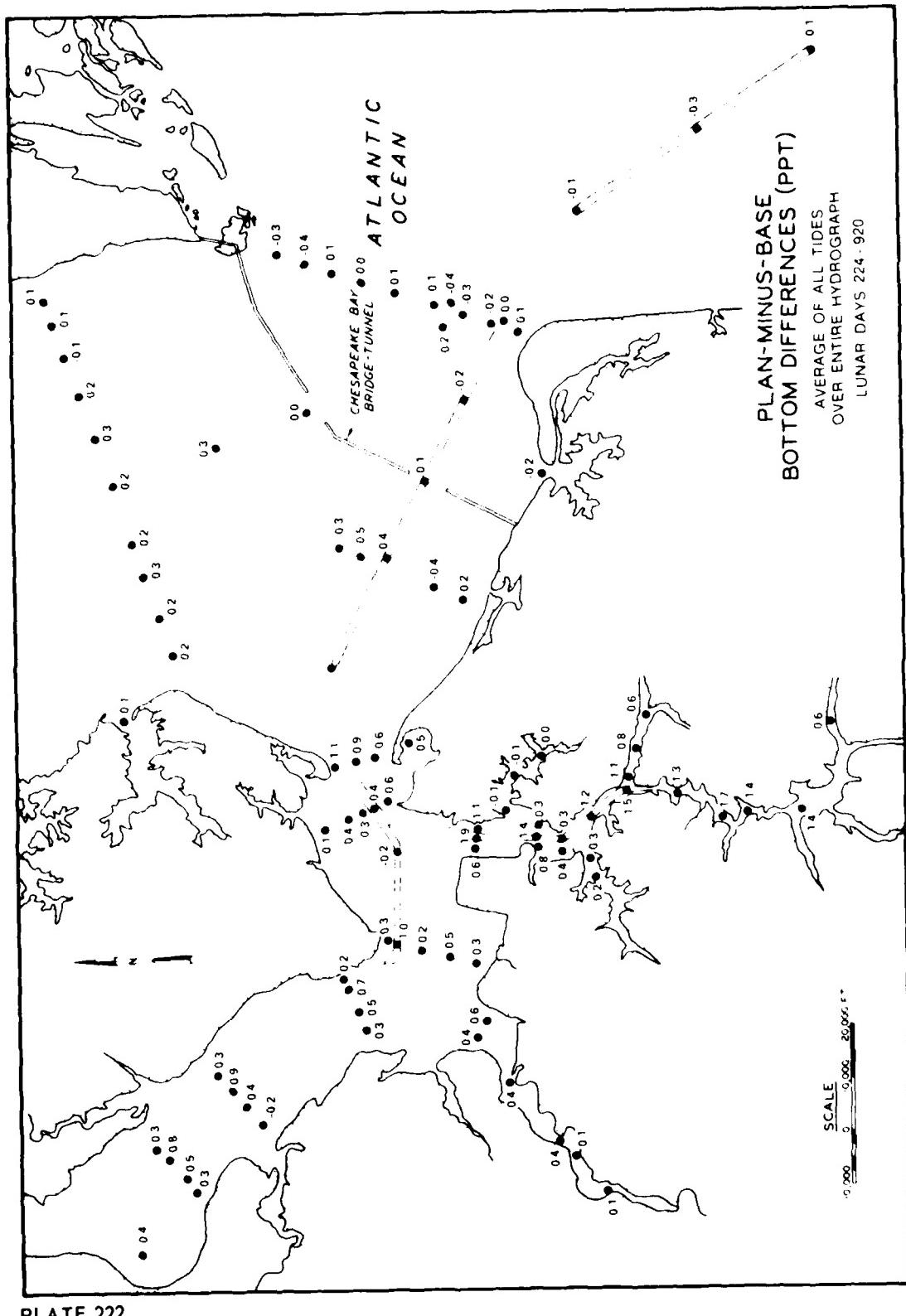


PLATE 221



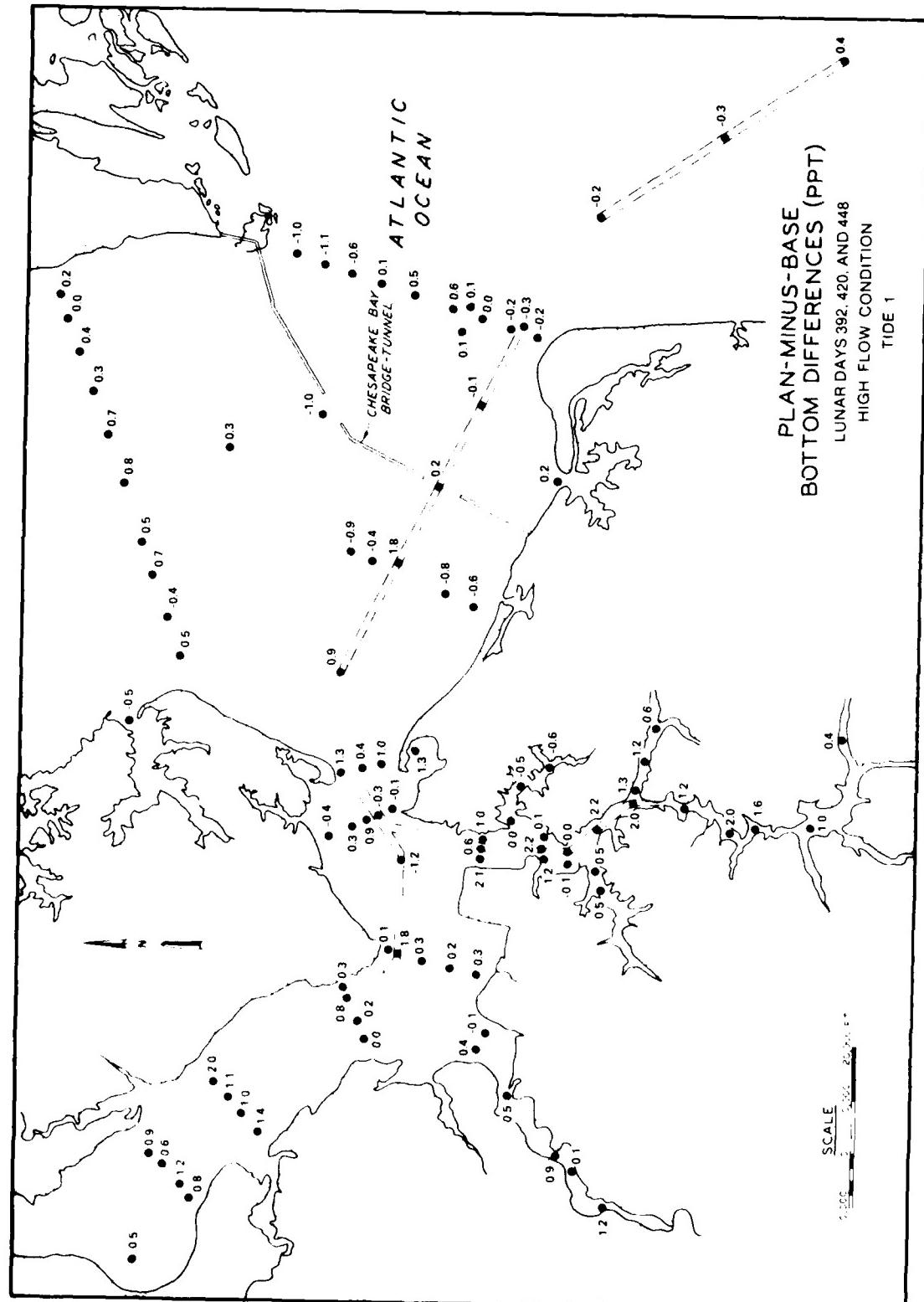


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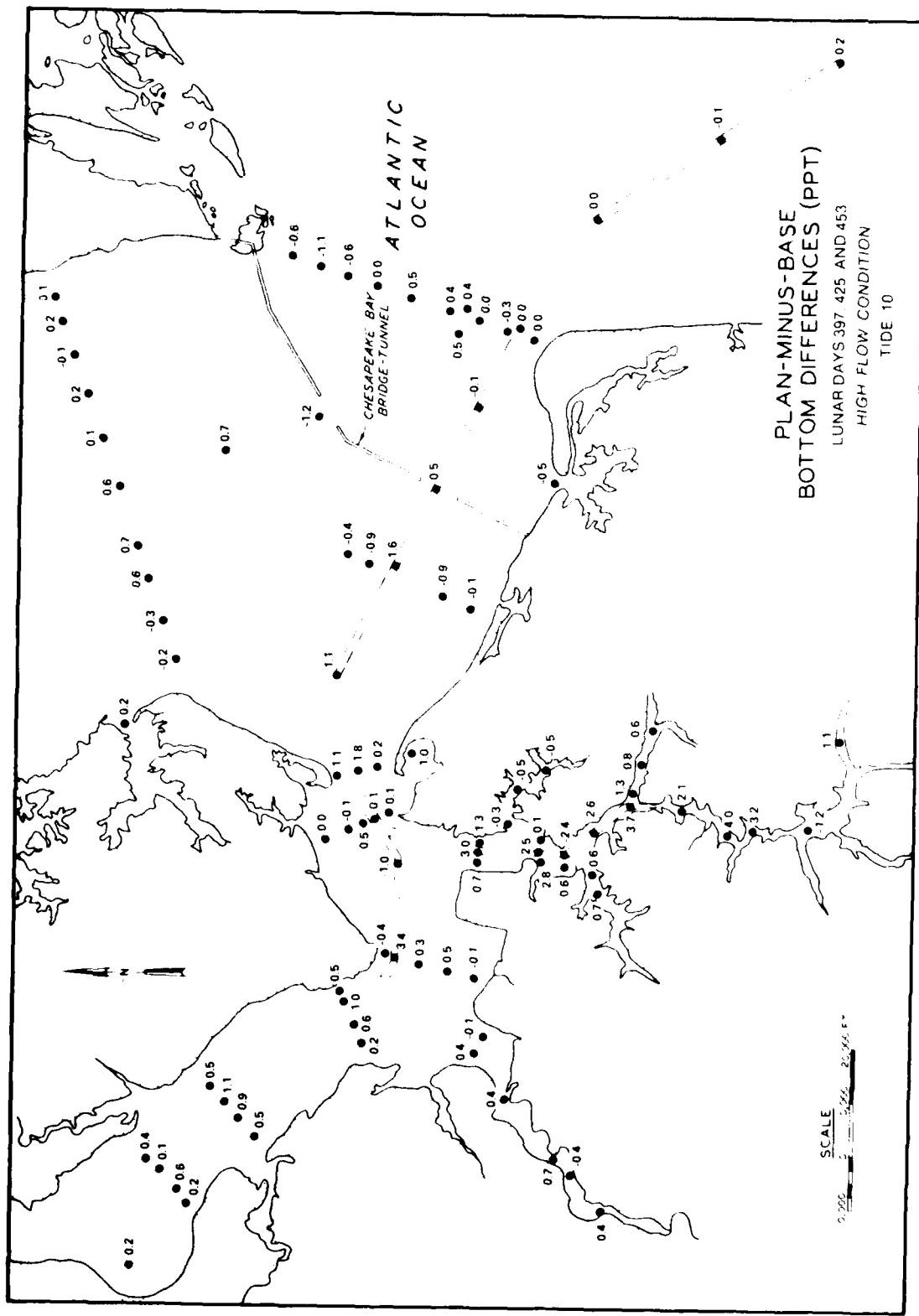
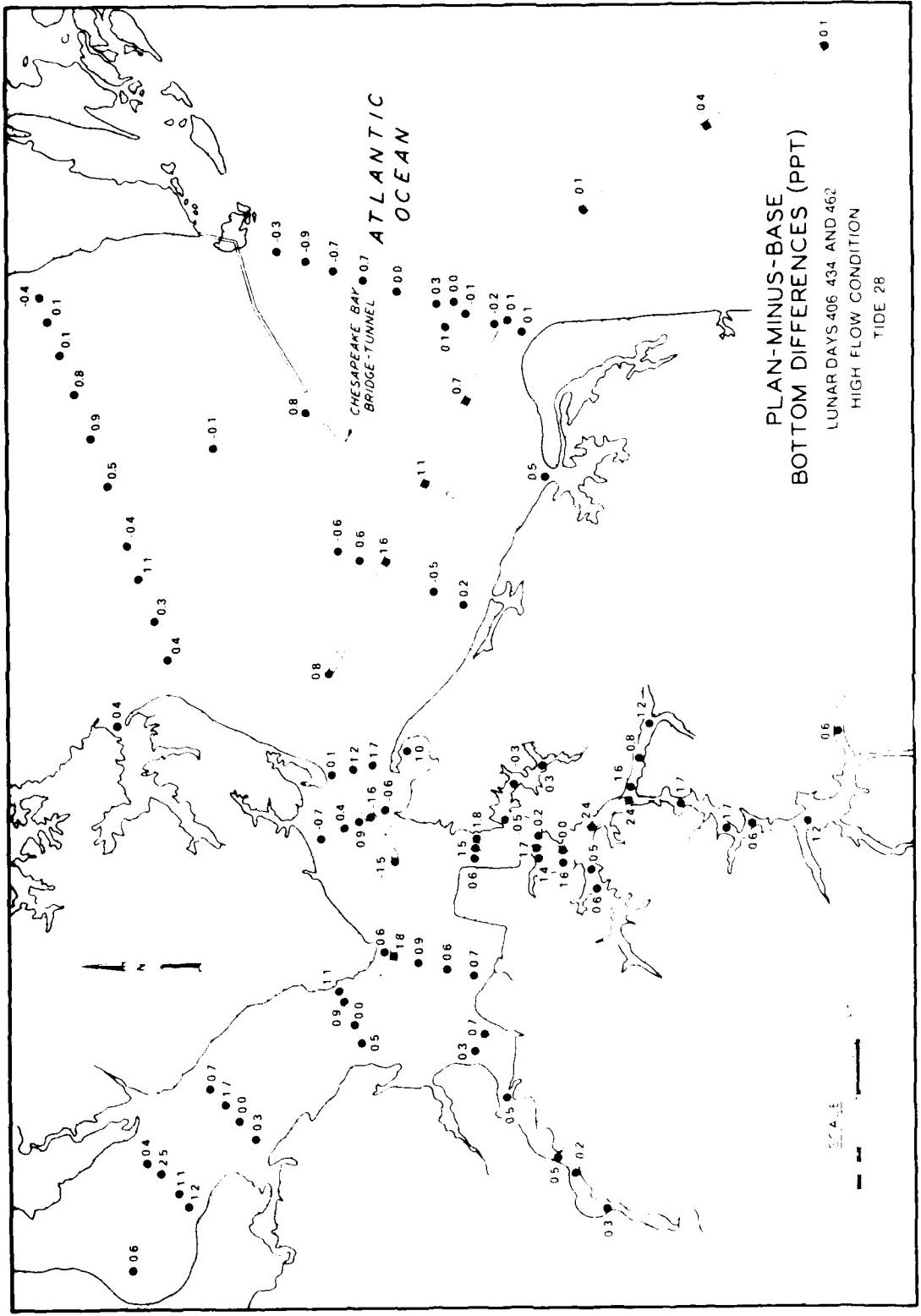


PLATE 224



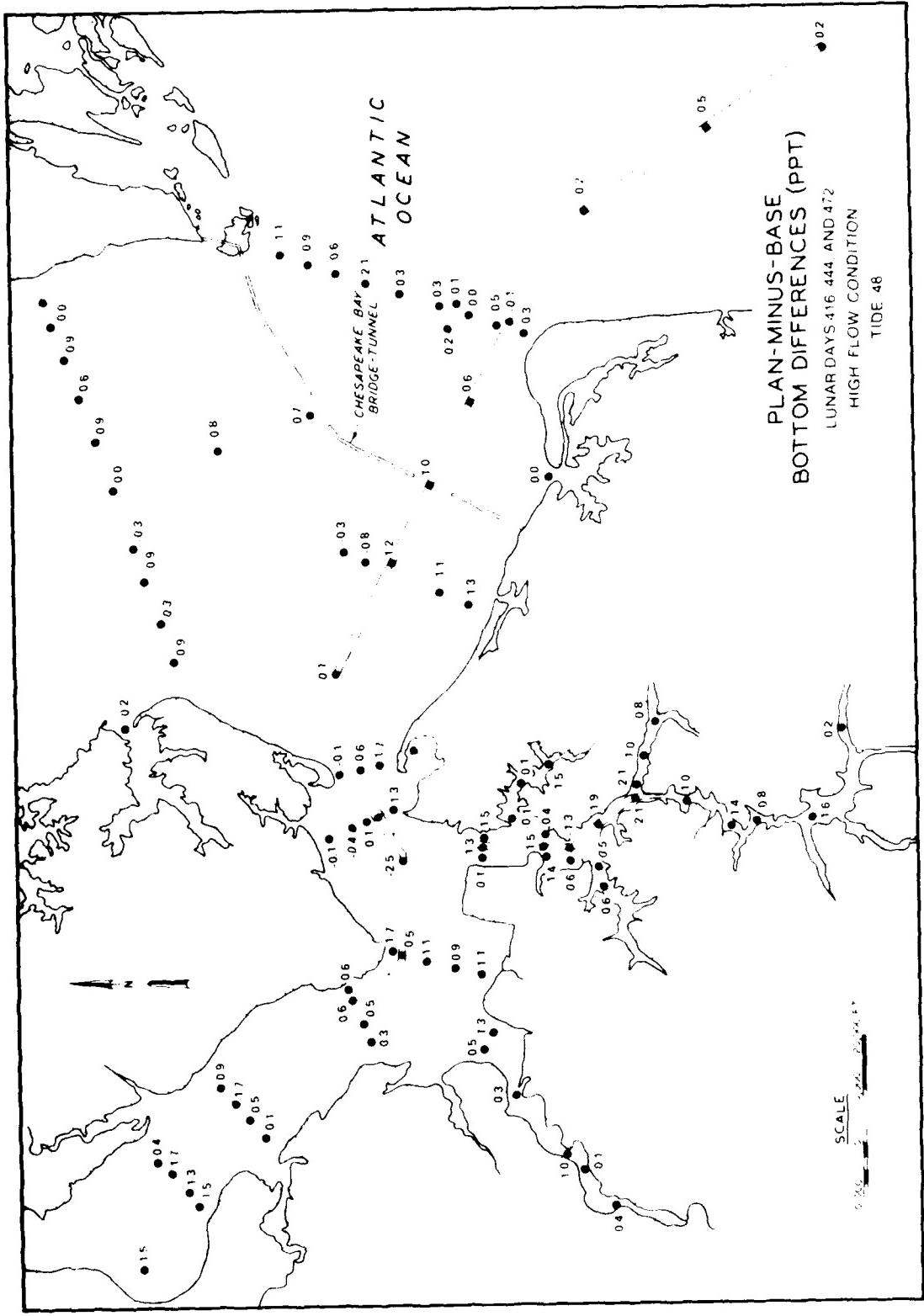


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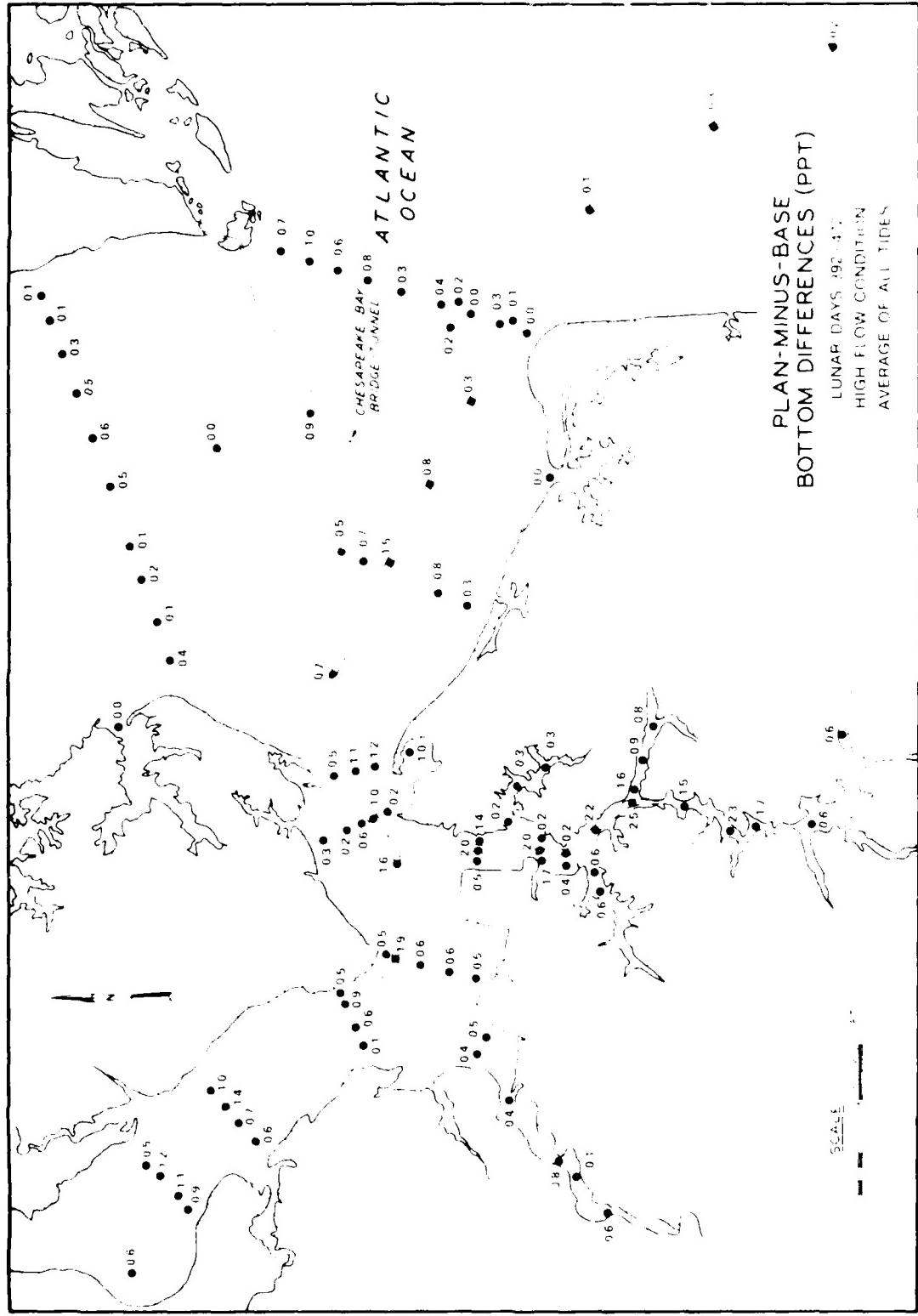


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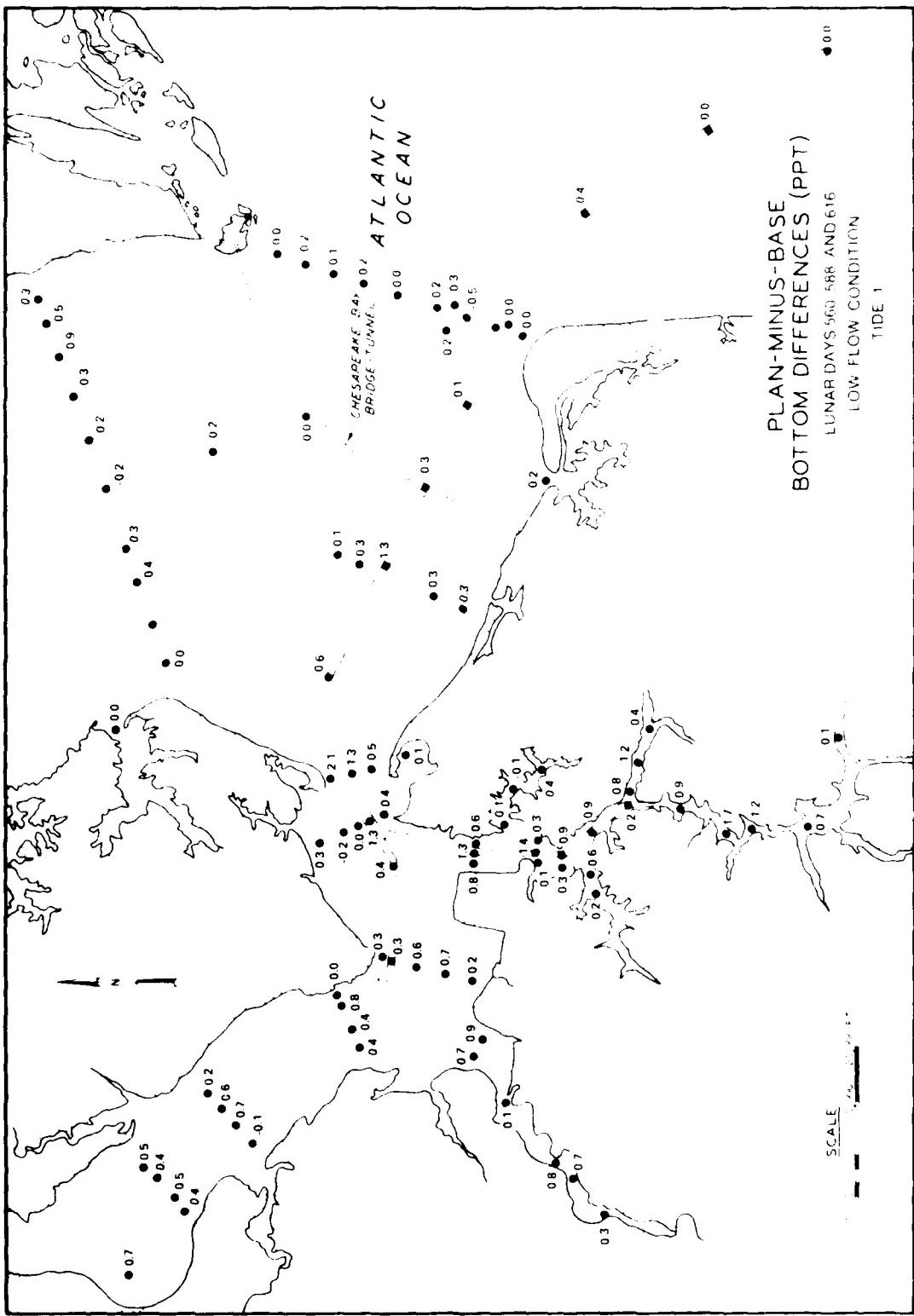


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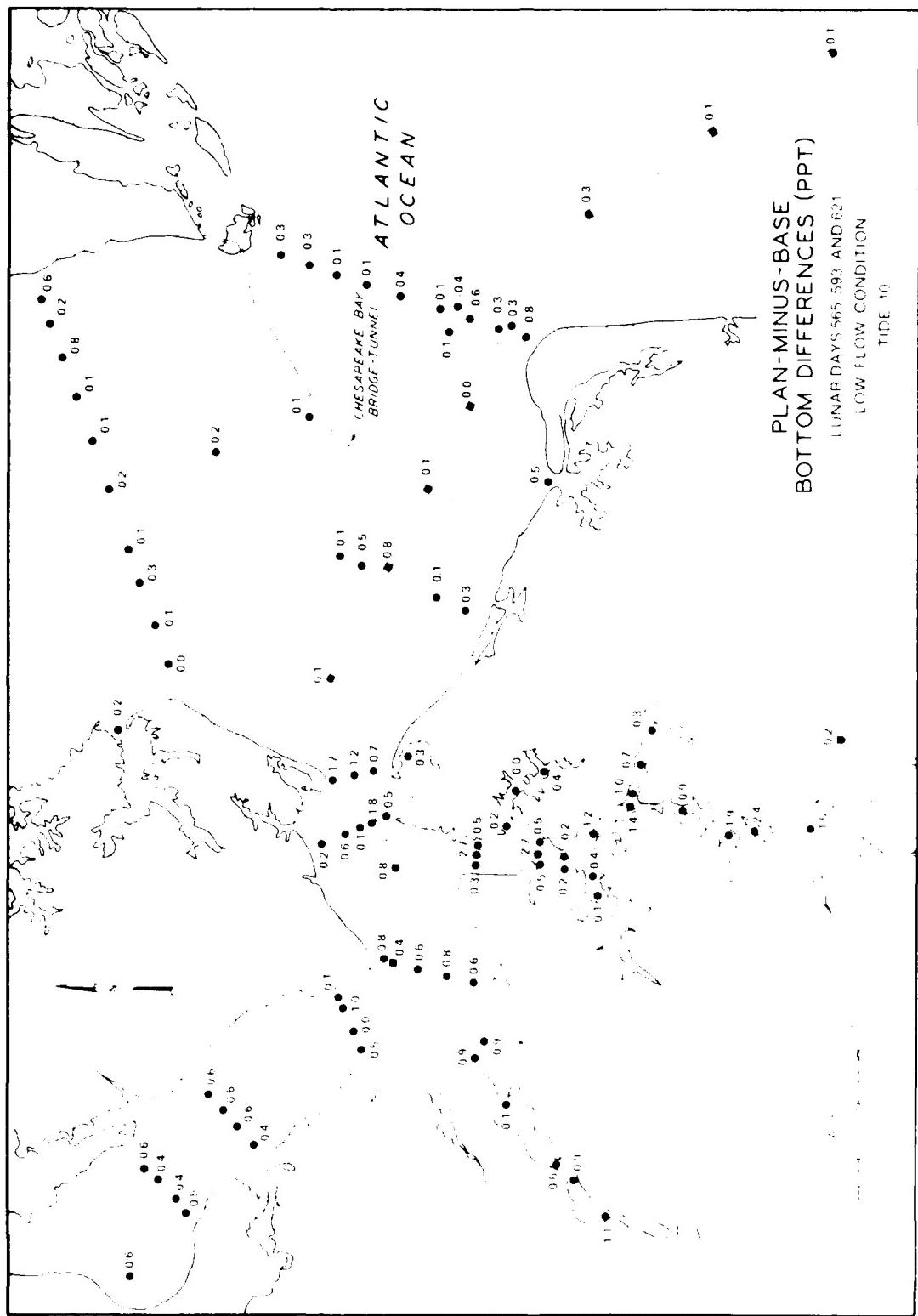


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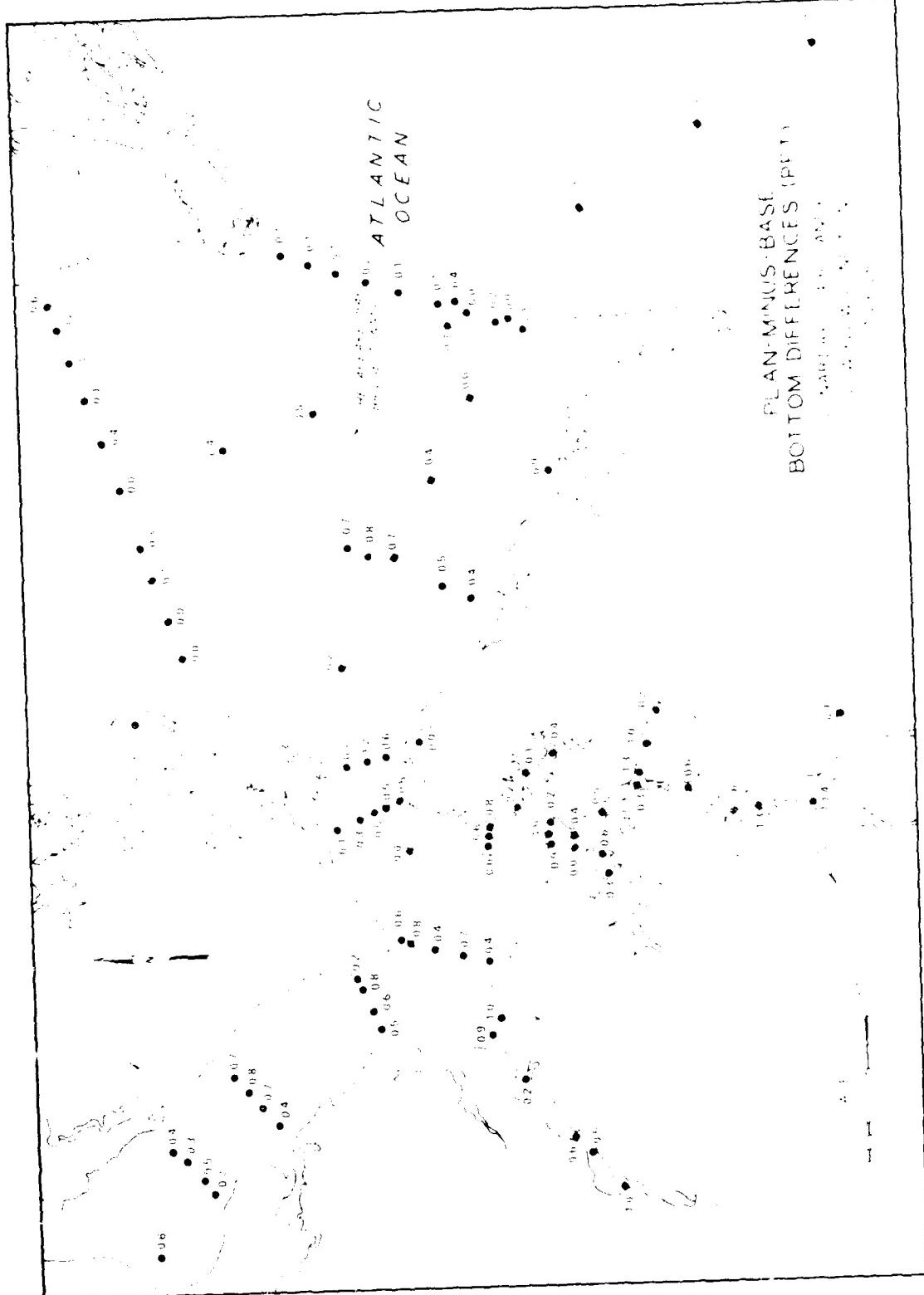
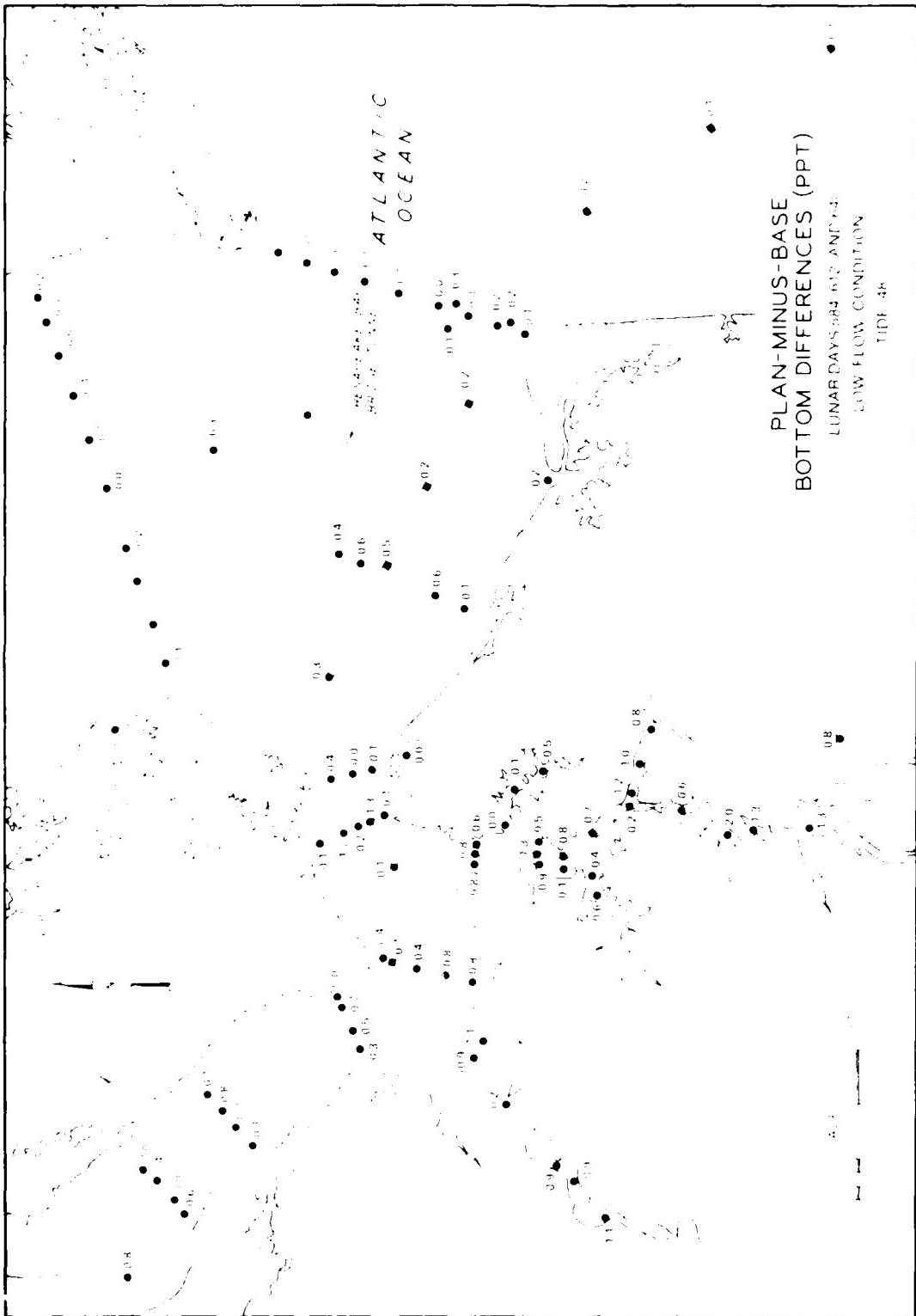


PLATE 230

PLAN-MINUS-BASE
BOTTOM DIFFERENCES (PPT)

LUNAR DAYS 584-612 AND 644
LOW FLOW CONDITION
TIDE 48



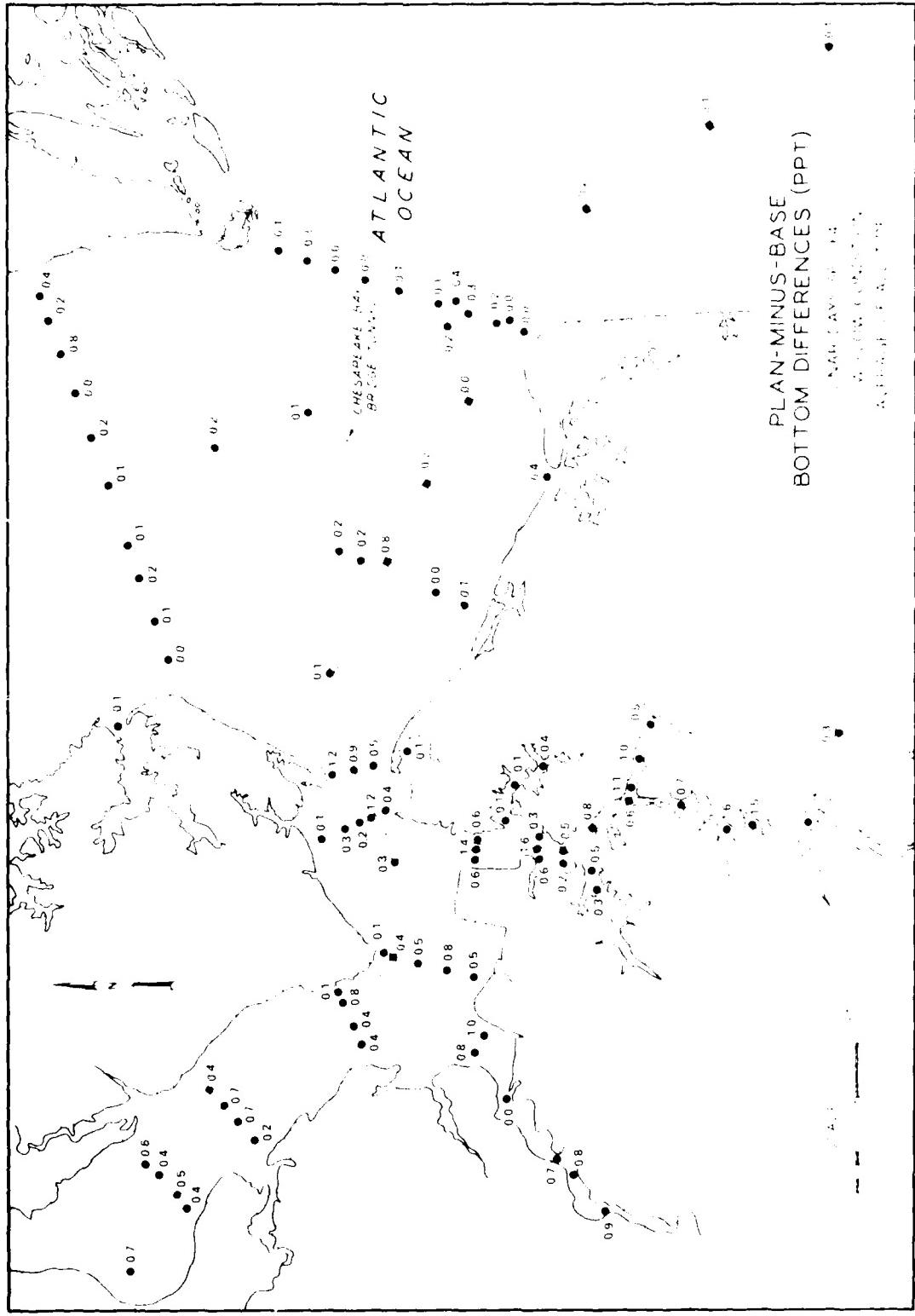


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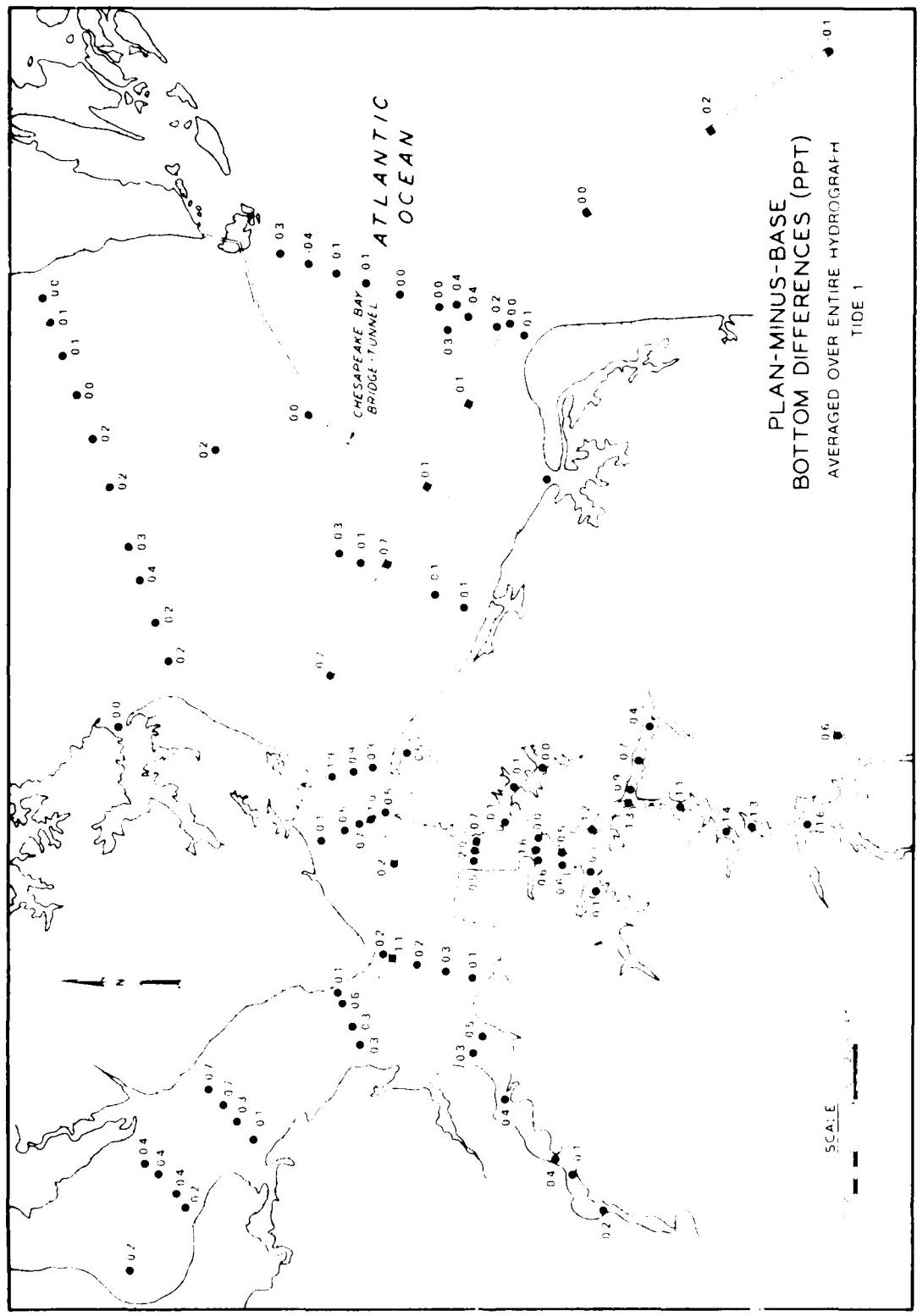


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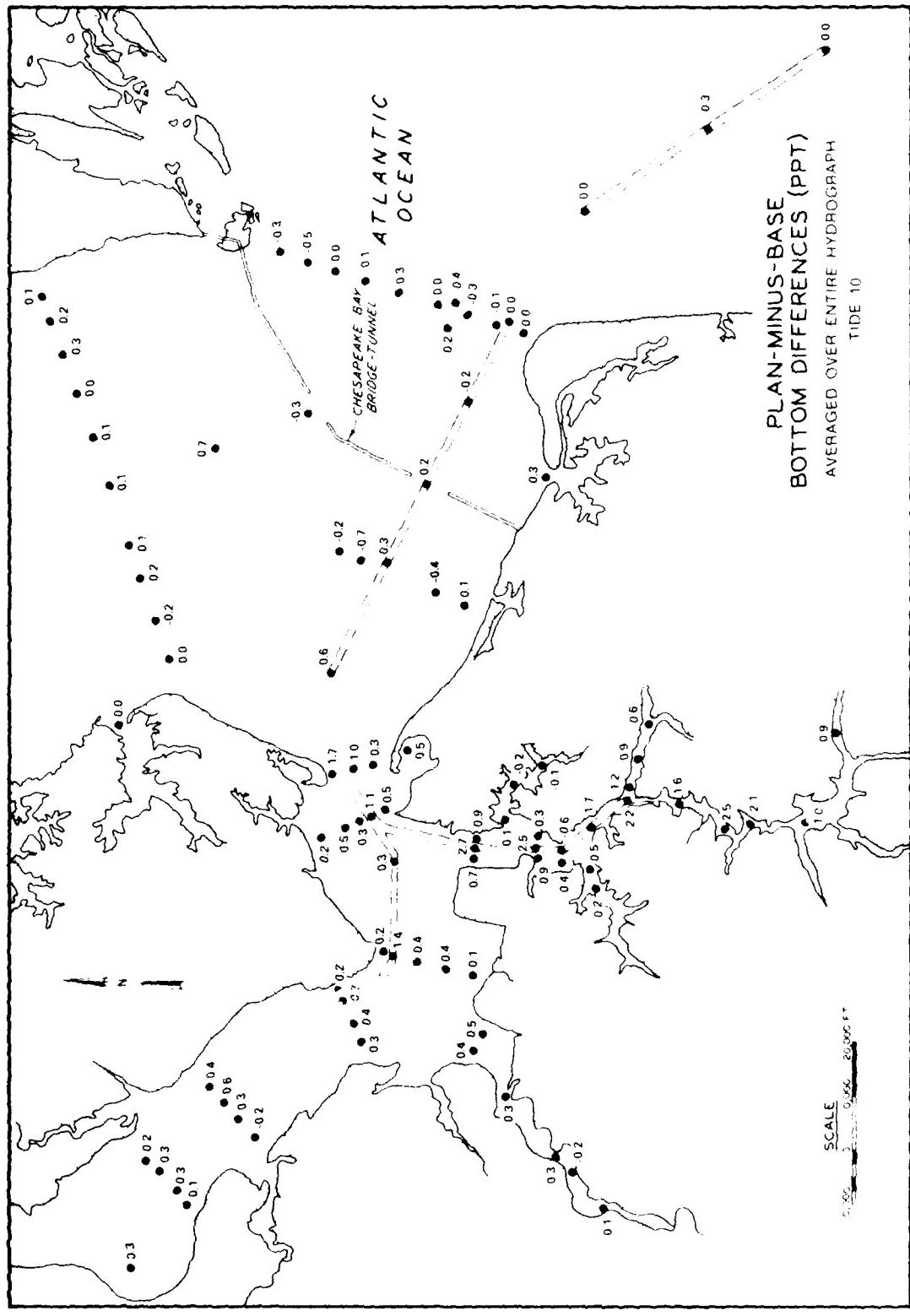


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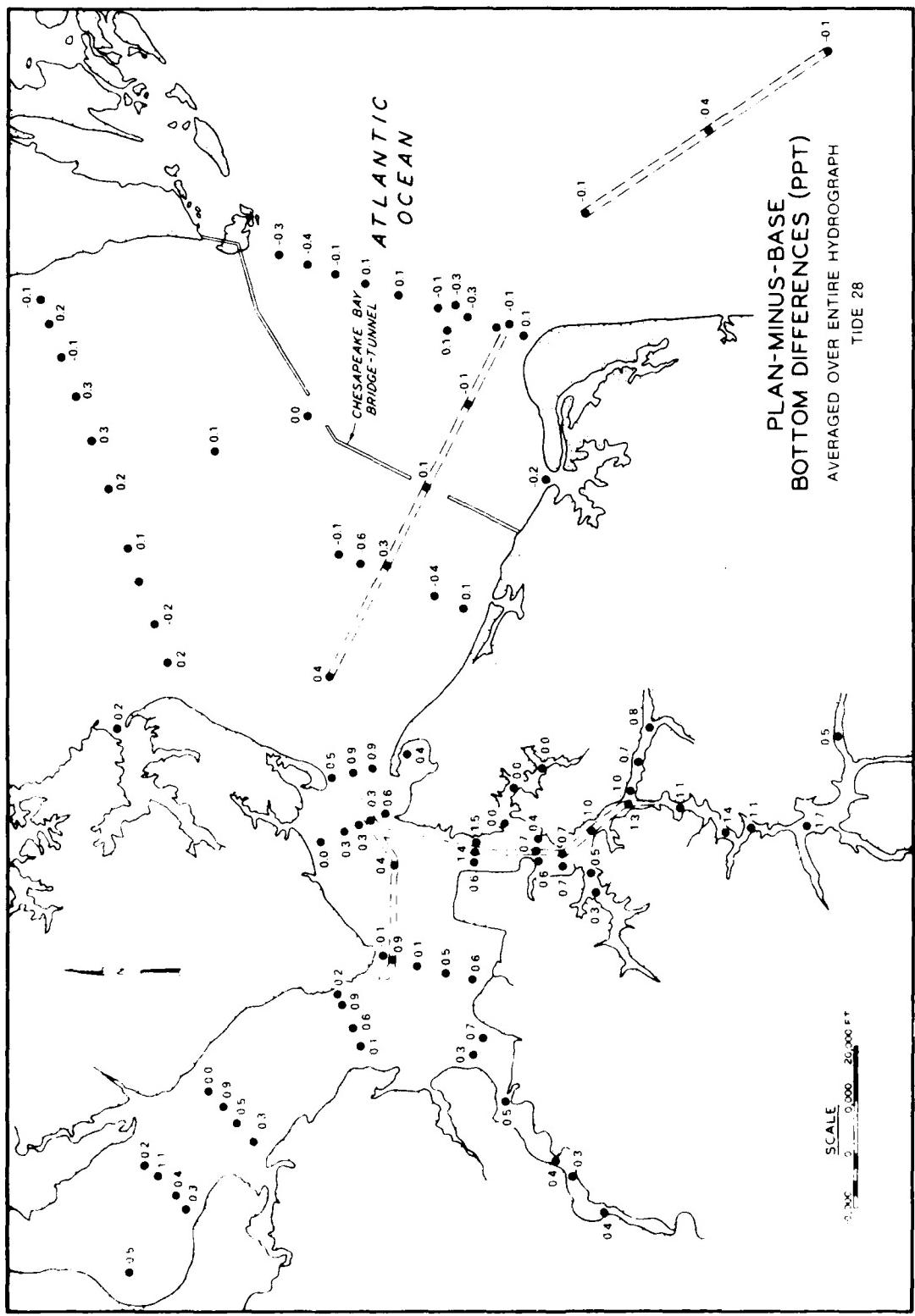


PLATE 235

